The Engineering News.

A Journal of Practical Science and Public Improvements.

PUBLISHED MONTHLY.

OCTOBER 15th, 1875.

## The Civil Engineers' Club of the N. W.

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Its formation originated with Chas. Paine, C. E., the present efficient General Superintendent of the Lake Shore and Michigan Southern Railway, and on the evening of the 25th of May, 1869, several members of the profession met by invitation, in the office of Col. R. B. Mason, when a committee was appointed, which on the evening of the 14th of June following, reported a constitution which was adopted, and under which, officers were at once elected for the ensuing year. At its organization the Club numbered twenty-two members, which has since increased to its present number of seventy-two. The primary purposes of the association were principally of a social nature. In the City of Chicago and throughout the Northwest were a considerable number of Engineers who were mostly engaged in very important engineering work; to bring these gentlemen together in social intercourse as often as once a month, for the purposes of mutual acquaintance, the interchange of opinions, the discussion of engineering subjects, and of the best means for the advancement of the interests of the profession, were the leading objects in organizing the club.

Like that of similar associations in the first years of their existence, the progress of the club has been slow and desultory, and its very existence even has at times been seriously threatened. Chicago is a city of "magnificent distances," and it required no small amount of zeal on the part of members, to induce them to spend a good part of two hours on the horse cars in the most inclement seasons of the year for the purpose of attending the regular meetings of the Club The great fire of 1871 interfered somewhat with the progress of the Society on account of the difficulty of obtaining a suitable place for meetings, and the great unpleasantness of travel through the burnt district. But notwithstanding these serious obstacles the Society has made steady progress. By an examination of the official list of names given in the last issue of ENGINEERING NEWS it will be seen that a considerable number are those of Engineers who rank with the highest class in their profession in the world, while with the names of many of the others are associated some of the most important engineering works in the country.

Since the organization of the Club fifty-four papers on engineering and collateral subjects have been read and discussed at the regular meetings; a considerable number of these papers have been published in the *Railroad Gazette* and ENGINEERING NEWS, and the collective information contained in the whole series forms quite an important contribution to the engineering literature of the day. Besides the reading and discussion of the regular papers, there has been an interchange of opinion on numerous important subjects relating to engineering, and could a fair attendance of members be relied upon for each meeting, there is no doubt a genuine interest would soon be created; non-resident members would plan to be oftener present and take part in the discussions; the inducements to become members of the Club would be stronger; a greater number of carefully prepared papers would be offered for discussion; donations of books, maps, and specimens of various articles of interest would gradually find their way to the Society's rooms, and it is not indulging in statements of an over sanguine nature when we say that, with its present start, the Civil Engineer's Club of the Northwest would, within two or three years, rank with the most influential societies in the country. When we look at the history of the Institution of Civil Engineers in England, and that of the American Society of Civil Engineers in this country, and consider the fact that they passed through just such an era of struggling for existence as that which this Society is but just emerging from, and that now they have both attained to national, and even, in the former society, to world-wide importance, by reason of the vast aggregate of scientific and highly practical information which they have disseminated through their publications, and the personal mental improvement of their members acquired by the interchange of opinions, and mutual acquaintance, which can only be gained by active participation in the proceedings of the societies, the members of this club may be encouraged to persevere and especially to note how the progress of these societies gained as the attendance and personal interest of each member increased.

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## The Cook County Surveyorship.

At the Convention held on the 15th in McCormick's hall, by the "People's" party of this city, (the party now in power,) Alexander Silversparre, a former employe of the Board of Public Works, received the nomination for County Surveyor by a large majority over S. S. Greeley and Alex. Wolcott, the two principal surveyors of this city, the latter being now, as he has been for many years past, the County Surveyor of Cook County. It speaks volumes for the party that their candidate is by all odds the most incompetent man, professionally or otherwise, of all the nominees on the list, except it is McDermott, who stood second on the ballot, and we doubt if there is another surveyor in Chicago who would be able to sink the present insignificant office of County Surveyor into deeper degredation in a single term, than the successful nominee of the People's party.

The *Times* of the 16th states that among others Mr. Greeley came forward at the Convention and pledged his support for the successful nominee for the office. We hope there is a mistake, and that it was some other man, as our regret at the prospect of success for Silversparre, can only be equalled by the sight of Mr. Greeley's seeking office at the hands of *such* a crowd as form the "People's" party.

We know of no surveyor in Cook county that is better fitted for the office than Mr. Greeley. He was educated for the profession at one of the best engineering schools in the country, and after a tour of observation in Europe, settled down in Chicago to the regular practice of surveying and engineering. He has held the offices of County and City Surveyor at different times, and most of the improvements that have been made in the practice in this city have been at his suggestion. He is a gentleman who has always maintained a character above reproach, and is fitted, by his extensive and accurate local knowledge of Chicago and the whole of Cook county, and his acquaintance with the minutest details of his profession, to make the office of County Surveyor in Cook county a respected one, and to reflect as much credit upon it as the superannuated old berth is capable of sustaining.

We have no fault to find with the present incumbent, Mr. Wolcott, and if he is nominated on the Republican ticket, as it is now probable he will be, we will support him with all the influence we can bring to bear, and we can hardly believe that such an apology for a surveyor as Silversparre can defeat him. His experience as a surveyor in this city is coincident with the city itself and we have always taken it for granted that he had a lease for life of his present office. He knows more of Cook county surveying in one minute than Silversparre will ever know.

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## CIVIL ENGINEER'S CLUB OF THE N. W.

CHICAGO, October 12th, 1875.

Owing to the prevalence of a severe storm at the time of the October meeting, and the absence of a number of members from the city, the attendance was so small that no formal meeting was held.

The next meeting will be held on the 2d of November at the Sherman House Club Rooms, beginning at 4:30 P. M. Mr. C. W. Irish, will read a paper on "THE ATTRACTIVE INFLUENCE OF RUNNING STREAMS OF WATER UPON THE MAGNETIC NEEDLE."

The paper omitted at the October meeting, and the business then postponed will also be presented,

L. P. MOREHOUSE,
Secretary.

## Constitution of the Civil Engineers' Club of the Northwest.

I. This Society shall be called the CIVIL ENGINEERS' CLUB of the North-west.

II. The objects of the Club shall be the promotion of social intercourse and the interchange of knowledge among the members; the raising of the standard, and the advancement of the interests of the profession.

III. Members shall be such persons as have been, or may now be, engaged in the practice of the profession of Engineering, as may be elected, upon the written recommendation of two members of the Club.

IV. *Sec.* 1. Candidates shall be proposed at one meeting and balloted for at the next, and they must receive three-quarters of the votes cast at the election; but the Club may, by the unanimous vote of the members present, elect any candidate at the meeting at which he is proposed.

*Sec.* 2. Any person who has been proposed for membership shall be duly notified thereof, by letter, according to form, enclosing an engagement to abide by the Laws and Regulations of the Club, if elected; and his name shall not be balloted for until he shall have returned the engagement with his signature affixed.

V. The officers of the Club shall be a President, a Secretary, who shall also act as Treasurer, and an Executive Committee.

VI. The President shall preside at elections, or whenever any business is to be transacted; in his absence the chair shall be taken by the oldest member present.

VII. The Secretary shall keep the records, conduct the correspondence, and take charge of the funds of the Club, of which he shall render an account at the annual meeting.

VIII. The Executive Committee shall consist of the President and two other members, who shall provide a place for the meetings of the Club, and perform such other duties as may be devolved upon them.

IX. Officers shall be elected annually, on the third Tuesday in June.

X. Each member shall pay, as an initiation fee, ten dollars, and a yearly contribution, payable at the beginning of each year, of five dollars.

XI. The funds of the Club shall be expended by the Secretary, upon the written order of the Executive Committee.

XII. Regular meetings shall be held upon the evening of the first Tuesday in each month except for June.

XIII. Members may, and are expected to, invite to the meetings of the Club, any Engineers, or other strangers interested in engineering, who may be visiting the city.

XIV. This Constitution may be amended, and any proposed amendment shall be submitted to the Club in writion, at a regular meeting; it shall be voted upon at the next regular meeting, when, in order to its adoption, it must receive three-fourths of the whole number of votes cast.

### AMENDMENTS,

*Amendment made June 13th, 1870.*

No. 1. From Section 1 of Article IV strike out the last clause, viz: "*but the Club may, by the unanimous vote of the members present, elect any candidate at the meeting at which he is proposed.*"

*Amendment made February 12th, 1872.*

No. 2. ASSOCIATE MEMBERS.— Persons engaged in engineering, or in kindred pursuits, but who are not eligible as members of the Club, may be admitted as associate members, after being proposed and elected in the manner provided for the admission of members.

No fees, nor dues, nor papers, shall be required from associate members, and they shall have no vote. They may, however, take part in the discussions of the Club.

Associate members may become members by being proposed and elected in the manner provided by the Constitution in Article IV.

*Amendments made December 9th, 1872.*

No. 3. Associate members shall pay the same dues and fees that are assessed upon members, or that are provided for in Article X of the Constitution.

No. 4. If any member, or associate member, shall fail to pay the dues, fees or assessments provided for by the Constitution or levied by the Club, after having been twice notified in writing by the Secretary that such payment is due, and shall allow the same to remain unpaid for three months after the date of the second notice, his membership shall cease and his name be dropped from the roll of members.

## Astronomical Notes—No. VIII.

PREPARED FOR THE ENGINEERING NEWS BY S. W. BURNHAM, F. R. A. S.

Mr. Hind, the superintendent of the *British Nautical Almanac*, will use Leverrier's new tables of Saturn, as soon as they are printed. This is the sixth astronomical table constructed by Leverrier, and incorporated by the Admiralty into the *Almanac*.

An interesting service to astronomy has been rendered by Mr. Davidson, the head of the American Transit Expedition to Nagasaki, Japan; he has determined the exact site of Abbe Chaffe d'Auteroche's observatory, in 1769, when he observed the transit by order of the French Academy of Science, at St. Joseph, California. As Abbe Chaffe died soon afterwards, from a fever caught while fulfilling his mission, his narration was completed by people who had never been on the spot, the blank left in his records has been filled up 108 years after the event. The Abbe Chaffe was an uncle of the celebrated Chaffe who invented telegraphs during the wars of the revolution.

A new telescope has just been completed by Merze, for the Observatory of Quito. It has an aperture of nine French inches, and has improved style of equatorial mounting. As Quito has an elevation of nearly ten thousand feet above the sea level, an atmosphere of great transparency and purity for astronomical observations will probably be found.

The great reflector of the Melbourne Observatory has been recently employed in producing a series of photographs of the moon, of very great perfection of detail. They are said to be equal to the similar works of Rutherford and Draper of New York.

Mr. L. Trouvelot, the artist, who made the beautiful astronomical drawing, published during the past year by the Howard Observatory, has been engaged to produce similar specimens of his art, by the aid of the great 26-inch refractor of the Naval Observatory. One of the first will be the planet Saturn, which will be shown with an amount of detail never before delineated.

The observatory of Jaussen is to built at Fontenay, at an expense of 80,000 francs. A sum of 50,000 francs, is to be spent on instruments, exclusive of the apparatus used on the transit of Venus. The instruments are to be under the direct supervision of the Minister of Public Instruction.

Prof. Watson, of Ann Arbor, on his return from Pekin, read a paper before the French Academy, on the observations of the transit made by his party. The question of the atmosphere, and the difficulty of determining the exact time of the contact were examined at length. Leverrier expressed the opinion that the determination of the Sun's parallax, by this method, was useless, unless some unexpected service should be rendered photography for solving the difficulty mentioned. Prof. Watson tried to discover to what height the atmosphere of Venus was liable to cause optical disturbances from its illumination by the sun, and he found it to be 55 miles, or about 1-70th the diameter of the planet.

Richard A. Proctor, the English lecturer on Astronomy, has arrived in New York. His first course of lectures will be given at Boston. He will visit Chicago sometime during his stay, when the large audiences present at his lectures, a year ago, will be expected.

## PUBLICATIONS RECEIVED.

THE RELATION OF PATENT LAWS to American Agriculture, Arts and Industries; being the annual address before the New York Society of Practical Engineering, delivered Sept. 7. 1875, by the President, Jas. A. Whitney.

## City News.

The contract for the completion of the Fullerton avenue conduit has been let to Messrs. Fitzsimmons & Connell. The work is to be completed by Dec. 1, 1876, and the price to be paid by the city is $314,201. The present contractors are obliged by the ordinance of the Common Council of the City, to take the plant and materials of Geo. F. Norris & Co., the former contractors, the value of which is $24,587.

In a future number of the NEWS we will give a detailed description of this important work.

Work on the Custom House has recommenced.

The paving of Wabash avenue is progressing as rapidly as possible. It is giving employment to a large number of men.

The Wabash Avenue Street Railway is a decided improvement. It is the best equipped route in the City, and the time made is the fastest. It is well patronized. The Chicago City Railway Company are endeavoring to give the public first class accommodations, and show a most commendable spirit. The report about ladies being insulted on the street cars is pure fiction.

"No Conductor, no Pay," is the war cry of certain parties who are trying to earn a cheap notoriety and save their car fares these hard times. We wonder if these philanthropists have ever tried genuine benevolence.

Street cars now run on Indiana avenue as far south as 39th street, and on Madison street west as far as Rockwell street railroad crossing.

Fitzsimmons & Connell are the new contractors for the completion of the Fullerton avenue conduit. Complaints are being made about their dilatoriness in commencing work.

Building operations in the city still continue active. The vacant lots in the business centre are being built on, and nearly all our leading streets show almost unbroken fronts.

## Mathematical Column.

IMPORTANCE OF MATHEMATICS.

In his dedicatory address, President Seelye, of Smiths College, Massachusetts thus speaks of the importance of mathematical knowledge: —

"It would be easy to show the increasing importance of mathematics to practical life, the assistance it gives the sailor and engineer, and our indebtedness to it for the most highly prized comforts of our civilization. But it is not for its practical utility that I advocate its place in the higher education. That utility, indeed, is due to the study, which had no thought of practical results. Nor does it owe its place to its importance as a mental discipline, although the testimony of many generations of Education witness to its value as an intellectual exercise. Rather would I justify the prominence of mathematics in the higher Education because it is the study, above all others which gives us a knowledge of the mind in Nature. To it more than to any other source, we are indebted for what we know of the physical sciences. Long ago its importance in astronomy was recognized. It made familiar to our commercial schools the secrets of the earth's motion, of day and night, and of the changes of the moon and tides. blems in the starry firmament about which the wisest sages for centuries were hopelessly puzzled, mathematics has enabled school boys to solve.

Yet its triumphs in astronomy represent only a fragment of what it has accomplished in the physical sciences. Sound, light, electricity, heat, have all become subject to mathematical formulæ: and algebraic signs explain to us not only how the subtle forces, unrecognized by any human sense, makes the music of the spheres, but how they interpret for us the music which we hear, colors which we see, and the warmth which we feel. So wonderful have been the results of mathematical analysis that modern scientific discovery has been forced to introduce it into all departments of physical science."

BAROMETRIC LEVELS.—To calculate the difference of level between two stations use the following formula:

$$H \text{ (in fathoms)} = 10{,}000 \log \frac{h}{h'}$$

in which $h$ and $h'$ are the heights of the barometer at the lower and upper stations respectively, the temperature of both the mercury and air being supposed to be 32° Fah. When this is not the case certain corrections are to be applied.

The height of any place in feet. is equal to the square of the number of quarter seconds occupied by a body in falling from the top to the bottom.

PORTAGE, AUG. 28th, 1875.

MR. EDITOR.

Sir:—Seeing a difference in results in the solutions of the problem "Fox and Dog," led me to investigate, by construction or projection, by which I find that the Fox run 129·6, and the Dog 162 rods. The radius of the curve, at its commencement, or major axis is greater than the semi-conjugate diameter, and decreasing gradually until the Dog has ran about half the required distance, when the Fox's course almost assumes the form of an asymptote to the curve for the remainder of the distance.

"Point and Square." I find size of square to be 20·0556 feet.

"Total pressure against Lock-gate," 111,375 lbs. (per Haswell's).

"Pressure against courses of Dyke," viz: 1st, 18th and 36th courses, 18750, 693,750, and 1,331,250 lbs. respectively.

As to "marking of corners ⅛, &c.," we, as Counto Surveyors, in Wiscontin, are required by law ty denote the quantities upon the Bearing Trees, *as ⅛ or 1-16 S., as the case may be. See R. S. Wis., Chapt. 13, Sec. 155. Your also find what constitutes ⅛ Sec. by referring to the Acts of Congress regulating the sales of the public lands.

"Ohio and Michigan boundary line." T H.'s remarks. page 107, August NEWS, coincides with my views on that subject.

"Blazed Section lines of lost ¼ S. corners." I invariably procure a copy of the Original Field Notes wherein is expressed the Station, Line or Sight trees on section lines. I use them, if any, but the Blazed trees, never. Trees referred to in the law of Congress are Line trees.

"Trigonometrical Surveying," August NEWS, page 106. Answered.

W E=489·04 yds.
E O=417·91 "
W O=265·25 "

Yours respectfully, H. M.

* The East and the West ⅛ qrs. of sections I denominate ⅛ S., but the S. ¼ of N. E. and N.W. qrs. of Sec. 1, for instance, I term 1-16 S.

Solution to problem 9.

1st Pressure=606·4 tons.
2d Pressure=316·0 "
3d Pressure= 8·5 "

A Ton being 1150 lbs., as per page 108 ENGINEERING NEWS.

Locomotive Driving Wheels.

$$S = \frac{n \times d}{28}$$

where $s$=spead in miles per hour.
$n$=number of revolutions per minute.
$d$=diameter of driving wheel in feet.

PROBLEM 13.

A body descending vertically drew another body of half the Weight up an inclined plane. When the bodies described the space $s$ the cord broke, and the smaller body continued its motion through an additional space $s$, before it began to descend. Required, the inclination of the plane. S. K. P.

PROBLEM 14.

Within a square garden is a stake so situated that the distance, to three of the corners, measures 6 rods, 4 rods, and 5 rods respectively.

Required the size of the garden.

Solution to problem 7.

W E=2,695 yds.=2591.5
E O=2,305 yds.=2216.
W O=1,464 yds.=1405.

Solution to No. 8,

49½ Tons pressure.

DUBUQUE, Sept. 26, 1875.

EDITOR ENGINEERING NEWS.

Dear Sir:—I send you solutions of the following problems as numbered in your paper.

Prob. 6.—Breadth of river, 107·02 feet.

Prob. 7.—Two solutions. 1st, when B is between W E and A C,

W E=479·19 yds.
E O=409·73 "
W O=259·90 "

2nd, when A C is between B and W E, then

W E=2640 yds.
E O=2259·2 yds.
W O=1426·8 "

Prob. 8.—1st, 111,375 lbs.

Prob. 9.—1st course, 28,750 lbs.; 18th course, 656,250 lbs.; 36th course, 1,681,250 lbs.

Prob. 11.—Height of A above B=993·9 yds.

Prob. 12. Pressure on each side wall=¼ W cot.

Yours truly, M. T., Jr.

PROB. 11.—Given BC=$a$=840½ yds

C B H=12° 10′; A B H=34° 20′; A C E=51°12′. To find A H, the perpendicular distance of A above B.

DEMONSTRATION.

A B C=22° 10′; A C D=40° 2′; B C A=180°—40° 2′=49° 58′.

Hence the side A B may be found since in the triangle B C A we have a side B C and two adjacent angles.

A B being known, A H is easily found from the right-angled triangles A B H, since the angle A B H =34° 20′ is known.

MANSFIELD, Ohio, Aug. 16, 1875.

MR. EDITOR:

I notice an error in the last line of my solution to the fox question, which should read

By the question

$$x = \frac{5}{4}\, x = \frac{100}{36}\, a = 166\tfrac{2}{3}.$$

Please make the correction.

Truly, J. N.

## CORRESPONDENCE.

EDITOR NEWS.

Dear Sir:—I would ask through the NEWS for information about building bridges of wood for common roads, or for use in towns of population up to eight or ten thousand.

I have always held that wood bridges of simple construction, for spans up to 100 feet might be made and maintained cheaper than the patent iron structures, more especially in a region where good timber is cheap. Will not some party who has experience in building wood bridges give us the benefit of that experience. This seems to me a field of pertinent inquiry, for our villages, towns, and counties are yearly paying large sums to outside parties for iron bridges that don't fulfill the conditions as promised.

Yours truly, J. E. S., Lansing, Mich.

PULASKI, O. Sept. 30th, 1875.

EDITOR "ENGINEERING NEWS."

In your last "J. M." would like to see an earnest discussion between the "pro-rata" and 'non-pro-rata' in planting the quarter-quarter posts of fractional sections. I will offer a few reasons for adopting *pro-rata* though I pretend nothing new. The pro-rata principle is applicable in any section. The utility of

the pro-rata measurement is this: it makes no difference what unit of measure you adopt, or whether it be correct or incorrect, as compared with a standard, if you divide those units of measure according to Government distances you will come to the same point. The non-prorata Surveyors unconsciously adopt prorata measurements in re-establishing lost corners on the sections proper. They measure the whole line and establish it at the equidistant point. But by their principle, having their chains tested by the U. S. standard, they ought to establish their quarter corner at forty chains from either section corner, which would generally vary considerably from the equidistant point. The pro-rata principle, if applicable in these cases, is applicable in all. Furthermore the Goverment says "each section on its subdivision shall be held to contain the exact quantity expressed" consequently that its recorded distances must be held to be the true distances.

Since Goverment maintains this, does not the non-pro-rata principle depose its authority by measuring off absolute distances, such as a forty or twenty chains. True, there may be measured off the quantity according to the U. S. standard, but there has been, as there properly should be, an authority established above this rule.

There must be an authority from which there is no appeal.

I will close by citing one case among many that I could cite in my own practice proving the pro-rata principle.

On the Goverment plat of a fractional section, for the first half mile was marked 40 chains; for the second 40.70 chains. Now, by the non-pro-rata principle, supposing the quarter corner lost, the first half mile would receive 40 chains.

When, however, I measured the whole distance I found the first half mile to be 40.22 chains and the second 40.92 chains, the quarter corner not being lost. Please test this by the two principles and determine which is most correct.

What more authority is there for establishing the quarter-quarter corner at 20 chains than the quarter post at 40 chains. Of course you will be giving 20 chains of your measure, but Goverment demands it, according to its recorded distances. Does not one quarter mile deserve its proportion of the excess or deficiency as well as the other. As to the phrases "according to the Goverment survey" and "more or less," I think, "with J. M." they ought to be wholly dispensed with as superfluous.

As to the "Fox and Dog" problem, I believe I must give "J. N." of Mansfield the credit for its correct solution.

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MR. EDITOR:

I thought it unnecessary, when I wrote my last article, to say any thing more in favor of the equal area system, for it seems to me as if any unprejudiced mind could see at once that equal areas are the only things that would do justice to the land owners. I have tried to show that the law of 1805 sustains equidistant corners in order to obtain equal areas. I did not think it worth while to try to prove the *justice* of equal areas, for this I thought would be admitted by all. But it seemed that J. M. thinks that if one quarter contains only 150 acres, and another in the same section, 170 acres, it is all just and right, because straight lines have made that difference. I hope never to be so prejudiced in favor of equidistant corners, as that, even though I think the law is in my favor. I think when the Government issued a man a patent for one quarter of a certain section—if not fractional—it meant *one quarter*, as near as could be, not changing the original survey—for the law is very plain that that shall stand. Now if J. M. will prove that the diagram given in the July No. of the News, as shaped and numbered, is a correct representation of sections as they came from the hand of the original surveyors, then I will say no more in defence of equidistant corners. But in my opinion he will not find just such a section in the United States.

I think that I am safe in saying that in ten cases where a "bad matter is made worse," exact straight cross lines will have nine of them. Yet he would make us believe that almost every practical surveyor divides by straight cross lines. I think there have been more sections divided by running just one line through the section and placing an equidistant corner, than by any method. Though that is better than exact straight lines, yet it does not come as near doing justice as equdistant corners both ways.

I wish to state one more argument in favor of equidistant corners. I think it was the intention of the originators of the law above referred to, that section lines should be straight, or near enough so, for practical purposes; and they *are* the *straight* lines of the Government, as much as Greenbacks are the *currency* of the Government. And if the section lines are the *north* and *south* of the Government, precisely so are they the *straight* lines of the Government. Hence *straight* was the only word that could be used in reference to lines. And I venture to say that if J. M. or any other County Surveyor had to run exact straight cross lines through a section in a dense forest, relying only on a magnetic needle, that it would be like perpetual motion "often studied and harped over, but has never been nor never will be accomplished." Perhaps his lines would not be as crooked as the section lines, yet he would call them straight, and the laws of the state would recognize them as straight. Precisely so, the government commanded surveyors to make their lines straight, so as to agree with the original lines; and as the original lines were called straight, ours wonld be called straight too, if they agreed with the original. But suppose we run exact straight lines, we violate the first and second sections of the law, for our corners are not equidistant, and our lines do not agree with the orignal. But if our lines have intermediate bearings—and they will have, if we have equidistant corners—then the work agrees with the original, both in corners and lines.

I am now through arguing this question, and leave it for some more able pens to handle; hoping they will take hold of it, either in a paper or book, I wait patiently to see.

J. V. B., Tipton, Indiana.

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SURVEY OF A "BLAZED" LINE. We are satisfied that we were wrong in our answer to the question of J. M., on page 106 in the August number of the NEWS, and that the opinion of a correspondent given in the last number is a better one. Within a day or two from the writing of our answer as given, we had occasion to run a section line where only a *very few* blazed trees were standing, and at the first 1/8 corner south of the quarter corner we found by following the blazed trees, that we were 40 feet to the east of the section line as given by a straight line between the posts established by "witness trees" at the quarter corner and section corner.

We know that the few remaining trees will be cleared off when the street as laid on the section line is graded, and we do not see any alterative but to run straight lines from the quarter corners to the section corners. We must here acknowledge that we never met with such a case before, the few lines in this region, in timbered land, being tolerably well marked.

THE SURVEY OF SECTION 6.—We still adhere to our opinion as to the method of dividing the N. W. ¼ of Sec. 6 to satisfy the call of the deed under the case supposed by T. N. The quarter section in question is simply a tract of land free of all restrictions as to its subdivision, either expressed or implied, and its owner A wishes to convey one quarter of its area to B. Neither the Government plat nor the "more or less" qualifications enter into the contract at all.

In practice we should expect to draw the attention of one or both parties to the government plat, which might show a very great difference between the areas of the several quarter quarters, and so learn the *intention* of seller and buyer, and act accordingly. But on the simple order itself from an agent of an unknown or distant client we should do as we have heretofore stated.

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## City Engineers' Salaries [1873.]

New York, N. Y.—Engineer of Water Works $6,500; Engineer of Roads, $6,000; Engineers of Sewers, $4,000. Surveyors are paid fees.

Louisville, Ky.—City Eng'r, $5,000; Prin'l Ass't, $2,000; 1st Ass't, $1,000; 2d Ass't, including Levelers, Clerks, and Draughtsmen, from 1,000 to $1,200, at option of City Eng'r. 3d Ass'ts, including Transitmen, from $60 to $70 per month; 4th Ass'ts, including rodmen, from $50 to $60 per month, according to merit; Junior Ass'ts, or chainmen, from $30 to $40 per month, according to capacity and usefulness. Prices of last three classes at option of City Eng'r.

Newark, N. J.—City Eng'r, $5,000; 2 Ass't @ $1,800, one @ $960; one @ 720; one @ $600.

Chicago, Ill.—City Eng'r, $4,500; employ from 6 to 10 Ass'ts, with salaries from $1,500 to $3,000.

St. Louis, Mo.—City Eng'r, $4,000; 1st Ass't $3,000; other Ass'ts from $2,500 downwards.

Pittsburgh, Pa.—City Eng'r, $4,000; 2 ass'ts @ $2,000; Ass't in charge of surveys has three field corps; Street Dep't, two corps.

Allegheny, Pa.—City Eng'r $3,100 (including salary from Park Commission, $600); 1st Ass't, $1,800; 2d Ass't, $1,200; Registry Clerk, $1,200; Draughtsman, $1.080; Ass't on new streets, $1,200; Survey corps (temporary) Ass'ts, $120 per month; draughtsmen, $90 per month.

Buffalo, N. Y.—City Eng'r, $3,000; 1st Ass't, $1,800; 3d Ass't @$1,250; Clerk, 1,250; draughtsman, $1,200 6 rodmen and axemen @ $700.

Cambridge, Mass.—City Eng'r, $3,000; assistance $2,862.74; horse, $500 (for year 1873).

Cincinnati, O.—City Engineer, $3,000; 3 Ass'ts @ $2,000; one @ $1,500; Draughtsmen, $1,500; rodmen from $45 to $55 per month. Total salaries for 1873, $15,600.

Albany N. Y.—City Engineer, $8,000; Deputy $1,500; temporary services of Draughtsmen during the year of 1873, $409.25.

Providence, R. I.—City Engineer, $2,750; $10,000 per annum for assistance and expenses.

Portland, Me.—City Eng'r, $2,500; 1st Ass't, $1,200; 2d Ass't, $650; 3d Ass't, $300.

Paterson, N. J.—City Surveyor, $2,500; assistance $1,000.

Lowell, Mass.—City Eng'r, $2,500; assistance, $2,000. City Eng'r also Engineer of Water Board.

Worcester, Mass.—City Eng'r, $2,500; assistance, about $2,000.

Rochester, N. Y.—City Surveyor, $2.500 one Ass't @ $100 per month.

Poughkeepsie, N. Y.—City Eng'r, $10 per day, for time employed; Ass'ts, $2.00 per day.

Norwich, Conn.—Services in surveying paid for by the day, at the rate or $7.00; assistance, $3.00 per day. City has no City Eng'r or Surveyor.

Fitchburg, Mass.—City Engineer, $8,407; assistance, $1,734.68, (1873).

Hartford, Conn.—City Surveyor, $8.00, for time employed; one Ass't @ $4.00 per day; one Ass't, $3.00 per day.

Springfield, Mass.—City Eng'r, $7.00; one Ass't, @ $1.50 and one @ 1.25 per day.

Lansing, Mich.—City Eng'r, $6.00 per day for time employed. Ass'ts allowed.

Alton, Ill.—City Eng'r, $5.00 per day, for time employed.

Ottawa, Kan.—City Eng'r, $4.00 per day, for time employed. Amount for 1873, $150; assistance for 1873 $100.

Oil City, Pa.—City Eng'r, $8.00 per day, for time employed.

Franklin, Pa.—City Eng'r, $10.00 per day, for time employed. Amount for 1873, $900; Ass'ts @ $250 to $300 per year.

Madison, Wis. City Eng'r, $5.00 per day, for time employed; no assistance allowed by city.

Middletown, Conn.—City Eng'r, 70 cts per hour, for time employed.

Auburn, N. Y.—City Eng'r, in 1872, salary, $1,000; 1873, $5.00 per day, for time employed. Am't from March, 1873, to February, 1874, $595; for Ass'ts, $74.00.

[TO BE CONTINUED.]

## Survey of Kings County, N. Y.

Kings County, Long Island, in which the City of Brooklyn is located, is one of the most important counties of the State of New York. It contains within its boundaries many large and important suburban towns, and has also an extensive water privilege, with interim basins, admirably adapted for harbor purposes. With its close proximity to New York City, and its superior advantages for suburban residence, it is destined in the near future to be densely populated. Although the land owners of the county were slow to to realize the demands of the times, yet finally decided to move in the matter, and in May, 1869, a commission was organized for the purpose of mapping the towns of Kings County. By various acts, passed from 1869 to 1874, the commission were given the exclusive power to "lay out streets, roads, and avenues, locate monuments, make special surveys, determine the width of carriage ways, sidewalks and court yards; provide for the custody of the street monuments, and for the arrangement of bulk-head and pier lines, and interior basins, also to make maps of all work, and copies to be filed in the town clerk's office of each town. The towns to be surveyed were New Utrecht, Flatbush, Gravesend and Flatlands, in all comprising 36½ square miles.

Samuel McElroy, C. E., was chosen superintendent of the survey, and under his direction the entire survey was made. The field work was commenced in July, 1869, and finished in the Fall of 1873. The entire area was laid out upon a regular city system of blocks, as it was considered that the interests of the public would be best subserved by doing so, and all future trouble of subdividing would be obviated. The district surveyed was laid out into blocks averaging 200 feet by 700 feet. A proximate estimate gives 4992 blocks, 1966 miles of streets, 279,548 lots, which at seven persons per lot, provides for a possible population or 1,956,836 persons. Adding to this the area of the Town of New Lots, which was not included in this survey, and the capacity of the five towns is sufficient for a population of 2,244,900 inhabitants. The number of monuments set was 2800. The streets were laid 60 feet wide; the avenues 80 feet; aud parkways 100 and 130 feet wide. The total expenditures of the survey were $85,994.

From the exceedingly interesting Report of the Superintendent of the Survey we make the following extracts.

### LINES OF MOVEMENT AND SYSTEMS.

A study of the experience of any old and populous city shows the great importance of placing the streets and avenues so that the blocks will range in lines parallel with those of greatest travel.

The City of New York was treated by Jno. Randall, Jr., C. E., in the general plan made by him, as a commercial city, wiih its chief movements from river to river; but experience has not confirmed his theory, and the system of blocks is reversed from what it should be, for up and down travel. As the streets lie across the line of movement, there is great inconvenience from the limited number of channels, and from the continued interruption of those which do exist, at short intervals, by the street crossings, and New York now has crowded avenues, and expensive projects for increased facilities in northerly and southerly travel.

Want of forethought in this matter is a fruitful source of expense in street widenings and openings, and the tendency of prominent centers to connect themselves by straight lines, often diagonal to intervening systems, is well understood in city experience. In the earlier days of city life, lines may be considered radical in size or direction, which prove, in time, wise preventives to legislation and costly rearrangement.

It is also to be observed, that in the vicinity of a great commercial city like New York, water fronts become valuable for business, for landings, ferries and otherwise, and where it can conveniently be done, there is an advantage in making the street system deliver towards them.

. . . . . .

### BASE LINE LOCATION.

In preparing for the extensive and varied work of this part of Kings County, I felt the necessity of simplifying this important detail. The attempt, in the varying changes of the day, to determine the temperature of a metal bar, laid on the ground, with a thermometer disconnected from it, as to accurracy of register for the bar, and multiplicity of notes and calculations, I wish to avoid; I also wished to obviate the multiplicity of level sights and corrections, and their chances of error; and also, the multiplied transfer stakes, for 50 feet lengths. Knowing that soft, clear, seasoned pine was much less affected by changes of temperature, than any metal, easy to construct, transport, and handle, I concluded to make a trial of it for our bases.

On this theory I arranged an apparatus consisting of a tripod about 7 feet long, carrying on a convenient drum about 600 feet of No. 13 annealed steel wire, and fitted with stay chains and a stout iron pin, to be driven in the ground and keep the tripod in place, when in use; also, a back stay rod, of the same length, driven in the ground, on line, supported by side stay chains and pins; between these the wire was stretched and supported at intervals of about 75 feet, by ordinary wooden flags, fitted with sliding rests and keys, so that when the wire was secured behind the back stay, to a pin firmly driven in the ground, it could readily be brought to a level; or if the gronnd did not so permit, to a uniform inclination, for a distance of 500 feet or more, over the sliding rests of the back stay rod and the flags, and certain intermediate rests on the back leg of the tripod. With a little practice this operation was rapidly and accurately made, the several flags, rod, etc., being first put in line on the main base, so that the wire near the back stay was plumbed from a plumb-clamp over the stake and tack, which was the starting (or intermediate) point of measurement. The wires being in line, under a tension of about 300 pounds, a pine rod 12½ feet long by standard, with brass butt carefully faced, was held under the wire with one end in contact with the face of the plumb-clamp, and a brass clamp properly faced and sliding on the wire, was put in contact with the other end and fastened by a hand-screw. A second sliding clamp was then put in contact with the first and fastened, the rod

being relieved. This clamp then formed the starting point for another measurement of the rod on the wire, being relieved and brought up to the forward clamp and reset as the measurement progressed.

We had then an apparatus light, simple, easily transported, not easily injured, which three assistants could work in the field a common spirit level sufficed for the wire in most cases, and in others, the notes were so taken that levels on the several stakes gave the data for corrections. The bases therefore did not require highly educated men, and the assistants were relieved from multiplied notes and calculations. Test benches of 500 feet were established, and the rod, in this way, frequently tested, and particularly after a wet interval, as it was soon ascertained that moisture was by far the chief source of any expansion.

In the more delicate processes of the Coast Survey, etc., temperature sometimes becomes a limit to work; in one scientific description 100° is made the limit: but our work had to go on in the hottest and sometimes the coldest weather. In former experience and an extended test here of the ordinary use of steel tapes or chains, it was clear without much study, that they were entirely unreliable in extremes; the same test however, fully vindicated the value of the wooden rods, as they needed care chiefly in the wet seasons. We were embarrassed also by the continual necessity of educating new men, those used being mainly students of college or technical schools, who were anxious to acquire practice, and quite as ready to leave for any increase of pay. Under these conditions, I consider this system of measurement the key to the successful completion of our work in time, cost, and correctness.

The same rods were used from July, 1871, throughout the field work. Theoretically, the effect of changes in temperature, taking the modulus of steel, as adopted by the Coast Survey, at 0'.0000064 for 1° Faht., and of pine (or deal), by Joule, at 0'.0000023, would be on 100° range, for 5,000 feet 3.20 feet in one case, and 1.15 feet in the other; practically we found the changes of the rods slight, as a rule, in different seasons. For instance, Rod No. 1, on 500 feet test, January 9th to 31st, 1872, stood 0'.022 short (for whole distance); February 7th, 0'.0165; April 12th, 0'.023 long; May 8th, 0'.029 long. Rod No. 2, in August, September and October, 1873, ranged from 0'.010 to 0'.020 long, on various intermediate tests. In July, 1871, a moisture test showed an expansion for a wet rod of 0'.500 in 5,000 feet; but as no measurements were made with a wet rod, our chief care was to detect the effects of absorption, which rapidly dried out.

In making the check measurement down 14th Avenue base, from 60th to 86th, the error was 0'.04, on a distance of 6,940 feet; and the diagonal base measurered down 4th Avenue, also checked and proved the transit lines. On part of the Ocean Avenue base line, a check measurement over a distance of 12,410 feet, by standard, came out 12,409.90.

## THE MECHANICAL ENGINEER:

### HIS PREPARATION AND HIS WORK.

[Extract from an address to the graduating class of the Stevens Institute of Technology, 1875, by R. H. Thurston, A. M., C. E., Professor of Mechanical Engineering.

You have given a large part of your time, during these four years of study, to the acquirement of a knowledge of the principles of engineering and to the practice of the arts which are of daily application in the practice of the profession. You have, from the beginning of your course, studied the theory of the graphic art and the geometry of machinery. You have spent such an amount of time in the drawing-room, copying well-known plans, and designing new forms of mechanism, that you have become familiar with every principle of common application in graphic construction, and with every detail of ordinary draughtsman's work. You will find this skill in sketching your plans, in making accurate drawings, and in reading the drawings of others, of daily use and of incalculable value to you. Without this power of comprehending plans existing only on paper, you would be absolutely crippled in your efforts to advance yourselves. Without the ability to sketch rapidly and draw readily and accurately, you would have the greatest difficulty in securing the prompt and thorough working of your own schemes. You have mastered the fundamental principles of applied mechanics and of mechanical constructiou, and have become acquainted with the nature and uses of the materials with which you are to work. You can, I presume, make a stronger lever of a built beam than could Archimedes. You have learned here probably almost as much of the characteristics of cast-iron as had Telford or Tredgold after years of professional practice. Fairbairn's lifetime of experiment and Kirkaldy's extensive researches have made you acquainted with the peculiarities of the malleable metals, and your own experiments have helped to impress old ideas and newly discovered facts upon your memories. The inventions of Cort and Neilson, and their important consequences in stimulating industry, and the splendid invention of our countryman Kelly and his British associate Bessemer, and the details of their discovery of a new metal and a new process, and the almost equally interesting and beautiful apparatus and process devised by Siemens, with their wonderful influence upon the development of the mineral resources and of every industry in all countries, are to you twice-told, but not the less interesting, tales. The growth of the mechanic arts under the stimulus of increasing intelligence and of awakened ambition as civilization has advanced, and the vast strides made during the past century, as invention has followed invention with ever-increasing frequency, have been studied with an interest that was quickened by the knowledge that the next few decades may see even greater wonders accomplished, and that to you, as well as to any other, it is possible that the honor may be accorded of worthily succeeding the great inventors and constructors of preceeding generations. The water wheel, the mariner's compass, gunpowder and nitroglycerine, the telegraph, the chronometer, the steam-engine, the printing-press, the spinning-frame and the loom, and a thousand other inventions, seem already perfected. Yet, some one, whether man of science or working mechanic or educated engineer, none can tell, will yet rival Fourneyron, and give us better turbines, will find a means of giving us safety in navigating iron ships, will excel Frodsham in making accurate timekeepers, will give us better printing-presses, will supersede the spinning-frame and the loom, and will earn a greater fame than Watt by giving us, in some new motor, a means of approaching that theoretical efficiency to which no heat-engine has approximated. A greater than Fulton or Stevens or Stephenson will perhaps yet accomplish the last and only unfulfilled part of a prophecy made a century ago by Darwin:

> "Soon shall thy arm, Unconquered Steam! afar
> Drag the slow barge, or drive the rapid car;
> Or, on wide waving wings expanded, bear
> The flying chariot through the fields of air;
> Fair crews, triumphant, leaning from above,
> Shall wave their fluttering kerchiefs as they move,
> Or warrior-bands alarm the gaping crowd,
> And armies shrink beneath the shadowy cloud."

Who has greater reason to aspire to fame and fortune in these coming years of such noble competition than have you? The development of the natural resources of this broad land of ours will afford ample opportunity for the application of your knowledge and the practice of your art, and for the employment of every faculty, natural or acquired, that you may possess, and in whatever way your inclination may prompt, and to any extent that ambition may urge, and that your strength and endurance may permit. Take hold of the work which offers itself, never standing idle waiting for something more perfectly satisfactory, and do the work as promptly and skillfully as possible, and you will ultimately find that no man need complain that opportunities do not present themselves.

You have completed this course of study. You have prepared yourselves to go out into the great field of business life. You have acquired a fund of information such as best fits you for life's work and to enjoy life's truest pleasures. You have learned to observe. You have acquired habits of study. You have a well-trained and well-balanced judgment. You are ready to go forth and—*to begin to learn*. You stand at the foot of the ladder, in the midst of a crowd of other men, all seeking to ascend, and many, I regret to say, ready to advance themselves by throwing others down. You possess immense advantages over the great mass of your competitors in your acquired knowledge, in the habits of study, of acute observation, and of logical deduction which this education has given you. Your competitors possess the advantages of training in the rough school of the world, of a knowledge of men, of business methods, and of the rights and the wrongs of daily experience. They have had hard knocks and become callous, or have learned by dint of long practice, and by natural tact, frequently, to evade them, and to push on without giving a thought to their scars. They will have the advantage of you at first, for these experiences are essential to early success. They may smile at your book-knowledge, and may sometimes even deride your more precise methods and scientific ways; but BIDE YOUR TIME! Make yourselves masters of all the accomplishments, and seek to acquire all of the knowledge, of these rough-and-ready but untaught

competitors, never refusing to give them a liberal reward from your own stores of information, should they ask it. You can afford to be patient, for this very training has fitted you to learn, even in their school. Be not obtrusive of your own knowledge, and never lose an opportunity to profit by their experience. Soon you will be able to command their respect, and it will be your own fault if you do not gain their esteem, and obtain from them cheerfully rendered and most substantial aid.

Finally, familiar with the usual methods, the practical details, and the every-day customs of the business, and possessing, besides, this splendid reserve of professional knowledge and of scientific and general education, you will find yourselves prepared to compete for the noblest prizes offered to your profession.

Remember who have preceeded you: Archimedes, whose lever was to have moved the world — whose lever does move a world of industry; Michael Angelo and Leonardo da Vinci, painters and architects, as well as engineers; Stevinus of Bruges, the greatest of his time, a scientific man as well as an engineer; Galileo, whose fame as a philosopher should not be permitted to hide his connection with our profession as a teacher of mechanical principles; James Watt, the greatest mechanical engineer of the last century, who made his greater inventions sequels to scientific study and experimental research; the Stevensons, the Rennies, the Brunels, Telford and Smeaton; Napier and Elder, Maudsley and Penn: Rankine, that great representative of a class of which we expect some of you to become exponents; —all of these in the old world, are your predecessors. In our own country, Benjamin Thompson, who became Count Rumford, John Fitch, Oliver Evans, Fulton, and our own Stevens, whose sons so nobly sustained the fame of their father, Roebling, our adopted fellow citizen Ericsson, Sickles, Hoe, Allen, and many others, have attained distinction, and their fame rises before you to stimulate a nobler ambition and to encourage you to never flagging efforts. Remember that the opportunities which are opened to you and to those who are to succeed you, are far more numerous than those which, grasped promptly and followed up determinedly by these great men, gave them fame and fortune; and the problems which it will fall to your lot to attack are likely to be no less important, no less difficult, and no less remunerative in reputation and pecuniary recompense, than those which gave to Newton and Rankine their fame, or Watt and Stephenson, Telford and Brunel, that professional reputation, which they share with our own great countrymen. The field is ever widening,and the work is of ever increasing magnitude. Emulate those great pioneers, and you may feel full confidence of rich reward.

*Never lose an opportunity.* Men rarely succeed in life who are neglectful of opportunities, and in nearly all cases, those who are successful can count upon their fingers the several occasions which formed the turning-points at which, seizing an opportunity that other men might have overlooked or neglected, they chose the path which led to their final success. Many men possess ability, intellectual and physical, but yet the number who may achieve high positions is small. It is the taking advantage of these rare opportunities, which, unobserved by the careless or the obtuse, are seized upon at the right moment and in the right manner by the watchful and the acute, that usually secures most rapid advancement. Life is short; great oppurtunities are rare; therefore, make it a principle never to neglect one, whether small or great; seize it promptly, and make the most of it.

*Endeavor to keep "two strings to your bow."* However much engrossed with the work in hand, however secure apparently your position, however satisfactory your location, keep the fact in mind that life is full of unexpected vicissitudes. Spare an occasional thought to provision against loss of position, failure of business, or compulsory change of location. Do your work so well that you may feel certain that your employer or your clients cannot afford to dispense with your services, and allow none of those about you to excel you. Yet be, at all times, prepared to make a new start, with confidence in yourself and your accumulated resources, should everything fail you. To ensure this, do your work better than can those who may aspire to your position. Have a specialty in which none can compete with you. Be always on the alert to make acquaintances among those whose character, position, and disposition may enable them to assist you when you find yourselves in need of assistance. Always assist your friends and deserving acquaintances heartily and actively. You will thus gain the approval of your own conscience, and will place a strong anchor to windward. The strongest man is weaker than a child if alone in the world without friends, and few men can say that they do not owe much of such success as they may have attained to the aid and countenance of good friends.

Endeavor to become thoroughly acquainted with the principles and with all the details of the practice of those trades which are auxiliary to the profession of mechanical engineering. Ability to calculate the proper sizes of parts, to determine proportions, or even to produce neat and effective designs, is of comparatively little service if you cannot follow your design through the workshops, and indicate every step, from the first blow of the blacksmith's hammer or the first cut of the pattern-maker's chisel to the finish given each piece and the "assembling" of all parts in the erecting shop. Do not feel satisfied until you can tell the pattern-makers how to make your pattern, the moulder how to mould it, and the founder of what mixture of metals you wish the casting made; until you can tell the blacksmith where to use the best and where to place the cheapest iron, and how to make his scarfs and welds, and how to preserve the fibre of the iron uninjured; until you can instruct an unskilful boiler-maker in the selection of his plate and in testing it, in the spacing of rivets and in the welding of a seam or the turning of a flange. Do not rest until you can take every piece of your machine as it comes from the foundry or the blacksmith's or coppersmith's shop, and fit it to its place, giving it the proper finish, in the cheapest, quickest and most accurate manner. All this will require time, patience, and perseverance, keen observation, a good memory, and a certain amount of actual practice to bring out that natural sleight, that mechanic's "knack" that no engineer in successful practice often lacks.

In doing your work, strive to earn a perfect self-approval. Whatever the pecuniary consideration, let no task be pronounced *done* until you can feel that it is as well done as the opportunities offered and your own abilities make possible. Endeavor to make every piece of professional work of such a character that you may feel conscious that it is creditable, and that you may always look back upon it with a comfortable sense of having done your very best to make it worthy of a good engineer and a credit to the profession. From first to last, work as if your sole object were to acquire a reputation for good work and to assume a leading place in your profession. You may then feel a perfect confidence that, if you earnestly seek to acquire and if you carefully cherish such a reputation for good work, honest dealing, professional skill, and general intelligence, your reputation will be very sure, in turn, to take care of you and to bring you competence, and perhaps wealth. You will, at least, certainly attain that which is better than wealth — self-respect, a quiet conscience, and the regard of all who may be brought into intimate relations with you.

And you will do your share in the work of making the extravagant words of Carlyle inapplicable here. You may remember where, in a published letter, he is said to have remarked:

"What a contrast between now and, say, only one hundred years ago! At the latter date — or, still more conspicuously, for ages before it — all England awoke to its work with an invocation to the Eternal Maker to bless them in their day's labor and help them to do it well. Now, all England — shopkeepers, workmen, all manner of competing laborers — awaken as if it were with an unspoken but heartfelt prayer to Beelzebub, 'Oh! help us, thou great lord of shoddy, adulteration, and malfeasance, to do our work with the maximum of slimness swiftness, profit, and mendacity; for the devil's sake. Amen.'"

This seems absurd extravagance, yet there is too much truth in it. But I believe that the world moves forward — never backward — and that we are continually approaching better days. Take for your motto, "*Fortiter, fideliter, feliciter*," and, doing your duty bravely, faithfully, and successfully, others will profit by your good example, and you will help us all onward while earning your own recompense.

Make the most of your resources. The greatest skill is frequently exhibited by the engineer in doing inexpensive work. In some cases the production of elaborate designs and graceful forms, the use of the best materials, and the employment of fine workmanship and the adoption of a beautiful finish, are not only allowable but incumbent upon you, and such construction is at once truly economical and most creditable. In other instances, the highest art is shown in accomplishing a given object at the least expense compatible with safety. Even rude devices, cheap materials, rough workmanship, and entire absence of ornament and finish, are evidences, at times, of the ability of the engineer to accommodate himself to circumstances and to accomplish large results with small means. The character of your work in this respect should be determined by the nature of the problem itself, by the means at hand, and by the value of capital. Where capital is plentiful and cheap, and where labor and good materials are plentiful and cheap, it would be inexcusable to design and to construct, in important work, anything but the best work that you are able to produce, using the best material and demanding the best of workmanship. Where capital is difficult to obtain, materials ill-supplied, and labor expensive, and where the structure is a temporary one, the really good engineer will pursue quite an opposite course. To build cheap railroads and machinery in Great Britain, where capital is worth but four or five per cent. per annum, and labor four or five shillings per day, as we build them in our West-

ern and Southern states, where money costs ten per cent. and labor is worth twice as much as abroad, would be extremely unwise. If it were stipulated that all new roads in the United States should be given easy grades, curves of large radius, or a straight track, well-ballasted, with cut-stone masonry and iron bridges, and furnished with station-buildings and permanent structures of stone and brick; if it were prescribed that they should be provided with an ample supply of the best rolling-stock, heavy locomotives, cars fitted with all the most recent improvements, and with every convenience known on old and wealthy roads, we should have no new roads, and the country would remain undeveloped. A machine designed for temporary use should be made at the least possible cost at which it will certainly serve its purpose. A machine which is expected to work well until worn out, and then to be replaced by another, should be made of good materials and in the best manner. Where it is anticipated that the machine will be superseded by another of improved design before it can be expected to become useless by wear, it is a waste of means to build it with a view to durability simply, and regardless of expense. It is for this reason that the light, cheap, but equally efficient machinery built by our mechanics for some branches of textile manufactures, and some of our lighter tools, are better, on the whole, than the heavier and more expensive machinery supplied by foreign builders. Improvements follow each other with such rapidity that it becomes necessary sometimes to throw out this finely-built machinery before it is half worn out. This difference in first cost is thus simply so much capital thrown away. Here, as in many cases that will arise, a good judgment, a strong, practical common-sense, guided by experience and enlightened by acquired knowledge, is your only reliance in determining where lies the golden mean.

## The Water Works of Virginia City, Nev.

The people of Virginia City, Nevada, claim to have the best and purest water of any community in the world, and when it is stated that the supply is obtained from a pure mountain creek, rushing down fresh and clear from the region of perpetual snow, the claim will be pronounced reasonable. But this priceless boon was attained at the expense of immense labor and the application of great scientific skill, by which was overcome the huge obstacle of the Washoe valley, which had to be crossed by the main pipe. The supply is from Dall's Creek, near Lake Tahoe, in the Sierra Nevada Mountains. The water is brought in an eighteen inch flume, four miles long, to a spur overlooking the Washoe Valley, 2100 feet above the Virginia and Truckee railroad track. There it is received in an iron pipe, which descends into the valley, crosses it and ascends on the other side to the height of 1540 feet above the railroad track at Lake View station. The length of this inverted syphon is a little less than seven miles. The amount or water thus introduced into the city is two million gallons per day, though this rate can be largely increased by a continuous full head of the supply. The leading of such a stream of water across such a valley is said to have no parallel in hydraulic engineering. The pressure on the pipe is enormous, and is estimated as the same as a column of water 1720 feet high. The orifice of the pipe is 12 inches in diameter. At the point where the pressure is greatest it is five-sixteenths of an inch in thickness, and riveted together with five-eighths inch pipe rivets. As the pressure grows less, the thickness of the pipe is decreased gradually till it reaches one-sixteenth of an inch. The amount of rolled iron used in the manufacture of the pipe is 1,150,000 pounds. A million rivets were used in its construction. It took 50,000 pounds of lead to fasten the joints of the sections. Before being accepted for use, each length of pipe was heated to the temperature of 380°, and plunged in a bath of asphaltum and coal tar, to prevent corrosion. The line of pipe is compelled to twist and curve to fit the inequalities of the ground, and crosses 13 steep canons. At the bottom of each depression there is a blow-off cock, used to remove any sediment that may accumulate. At each elevation is an air vent. The water, when received into the pipe from the flume passes through wire screens and charcoal.

## The English Royal Railway Train.

During the passage of the royal train which conveys Her Majesty and suite between Windsor and Ballater, on the London and Northwestern Railway, the ordinary arrangements for working the line are suspended. The exceptional nature of the regulations then adopted must be considered as affording the nearest approach to perfection in railway traveling that has yet been arrived at. The train is fitted throughout with continuous breaks, with an electrical communication between the compartments of each saloon and carriage and the guards, and with a communication between the guards and the driver. A pilot engine is run fifteen minutes in advance of the train throughout the entire journey. In order to guard against any obstruction or interference with the safe passage of the train, no engine (except the pilot), or any train or vehicle is allowed to proceed upon or cross the main line and stations during an interval of at least thirty minutes before the time at which the royal train is appointed to pass.

All shunting operations on the adjoining lines are suspended during the same period. While, after the royal train has passed, no engine or train is permitted to leave a station or siding up on the same line for at least fifteen minutes. In addition to these regulations, no light engines or trains, except passenger trains, are allowed to travel between any two stations on the opposite line of rails to that on which the royal train is running, from the time the pilot is due, until the time the royal train has passed. The precaution is also taken of especially guarding every level crossing, from crossing and station, to prevent passers, and of securely bolting all the facing points over which the pilot and the royal trains have to travel. Plate layers are also posted along the line to prevent the possibility of any impediments at the occupation road-crossings. Special arrangements are made for telegraphing the passage of the train from point to point, as it speeds along its journey, and an instrument is conveyed by the royal train by means of which a telegraphic communication can be established at any place on the journey in case of need.

The train is accompanied by a sufficient number of fitters, lampmen and greasers, who keep a constant watch on each side of the train, so as to notice any irregularity in the running of the carriages; and who, upon the train stopping at the appointed station, examine it throughout and grease the axle boxes. The average speed of the train is 36 miles an hour excluding stoppages.

ASCENSIONAL FORCE OF A BALLOON.—To find the ascensional force of a hydrogen balloon, multiply its contents in cubic fathoms by 15, and from the product subtract the number of pounds weight in the car and balloon. When coal gas is used multiply by 8¼ instead of 15.

## Law and Legislation.

An abstract of decisions of the Supreme Court of the United States and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc. Compiled for the ENGINEERING NEWS by John Dunn, Esq., Attorney at law.

301. If adjoining proprietors erect a monument to conform to a deed under which one of them claims, that act is evidence of the boundaries between them or their privies, although done ten years after the grant. Gilbert v. Curtis, 37 Maine, 45.

302. Traditionary evidence, and the diagrams, certificate, and declarations of deceased persons, are inadmissible to prove the boundaries of estates; otherwise in regard to boundaries that are of public interest. Chapman v. Twitchell, 37 Maine, 59.

303. In determining town lines by reference to a plan and to a survey, if these two differ, the more certain is to be followed. Wesley v. Sargent, 38 Maine, 315.

304. Where the owners of land order their surveyor to determine the town lines, and he fixes them erroneously on his plan, and the owners act ignorantly upon it, they are not bound. [Ibid.]

305. The location of a monument for one purpose has no effect upon a distinct question not then existing. Talbot v. Copeland, 38 Maine, 333.

306. In the absence of bounds, the dividing line must be run by aid of the measurements in the deeds, the older title receiving its full measure first. [Ibid.]

307. Where a fence across flats between two farms had been kept up for a long series of years nearly in the same place, but not permanent and stationary, and no continued and adverse possession to the line of the fence for twenty years was shown, it was held that no legal presumption arose that it was the true boundary between the farms, and that its location was only evidence to go to the jury of an agreement and acquiescence of the parties in that line as the true one. Knight v. Coleman, 19 N. H., 118.

308. Under a statute by which a stream not navigable is made the boundary of an incorporated territory, the centre of the stream and not the edge or margin is the true boundary line, and this is so even though the monuments are described as standing on the margin or bank of the stream. Cold Spring Iron Works v. Inhabitants of Tolland, 9 Cush., (Mass., 492.

309 Courts are bound to take cognizance of the boundaries in fact claimed by the state, and will exercise jurisdiction accordingly. State v. Dunwell, 3 R. I., 127.

310. Where adjoining proprietors abut on opposite banks of a stream, their boundary line will follow the natural and imperceptible alterations in its course, but not changes caused by artificial means. Halsey v. M'Cormick, 3 Kernan, (N. Y.) 296.

311. Maintaining a fence for many years is strong but not conclusive evidence of limitation of claim to the boundary. Potts v. Everhart, 26 Penn. State Rep., 493.

312. Where the owners of adjacent tracts of land run and staked off a line, supposing it to be the true line between them, and had so considered it for more than twenty years, but there was no actual possession

in the case, the original rights of the parties are not thereby altered, and the true line being afterward ascertained and fixed, the respective owners will hold according to it. Carroway v. Chacey, 2 Jones Law Rep. (N. C.) 170.

313. A marked line of another tract, which can be established by its memorials, must be run, disregarding distance, when called for in a conveyance; but where such line cannot be established, the distance run must govern. Gause v. Perkins, 2 Jones Law Rep. (N. Y.) 222.

314. Where lands are conveyed bounding upon a watercourse, or other varying limit, and reference is also made to a plan, the date of the conveyance and not the date of the plan, is to be considered in determining the question of the true boundary of the land upon the water limit, and the claim for alluvion, Jones v. Johnston, 18 How, N. Y., 150.

315. Land marked on a plat of a village or a street, which has reverted by non-user, will pass by a deed of "all land not designated and numbered." Wanzer v. Blanchard, 3 Mich., 11.

### Increased Safety in Railway Traveling.

Two very useful electric contrivances for promoting the safety of railway travelers, patented by Messrs. Garham & Co., were exhibited last week at the office of Mr. William Smith, C. E., preparatory, we believe, to their removal to Bristol, where they will be shown in connection with the British Association. The first is the joint invention of Messrs. Stroudley & Rusbridge, of the London and South-Western Railway Company, and is designed to furnish a means of communication between the front and rear guard of a passenger train, and the passengers. The five o'clock express from Brighton is fitted with this. An electric communication runs through the train, bells being in each guard's van. A button is in each compartment, which being pulled out rings both bells until the guard replaces the button with his key. The train may be divided into any part without detriment to the working of this, except that only one bell instead of both can then be sounded. The ordinary cord communication can be utilized with this invention in case one or more ordinary carriages are added to a train thus fitted. A slip electric coupling is used in trains of which any portion is to be slipped while running. The other invention is Harper's patent train signalling apparatus, its object being to provide a means of electric signalling which shall stop trains when approaching a junction, and thus obviating the possibility of a collission. The "up" and "down" signals are placed on different halves of the dial, and an ingenious contrivance is provided which nullifies any design on the part of the signalman to falsify his signals.—*Iron.*

Several Civil Engineers, engaged with the surveys for a water conduit from Tonja to Bougie, have made a very interesting and important discovery. A mountain which was situated in the proposed line of the conduit was to be tunneled for a length of 500 yds; and in searching for the most suitable place the engineer discovered an ancient tunnel 6ft. 8in. in height, and 19ft. 7in. in circumference. It is supposed that this is the same tunnel mentioned in an epigraph found at Lambeoc, according to which the tunnel was built in the reign of Antonius Pius, the plans being prepared by a veteran of the Third Legion, named Nonius Datus. Finding works like this after a time of 2000 years, we cannot but be greatly astonished at the power, energy, and genius of a nation which produced, with the limited means available at those times, such gigantic structures.

### The Use of Narrow Gauge Railways.

They begin to talk of railroads down in Mexico, and the Mexicans see the importance of building a line to connect with our railroad system, to give them access with their products to our markets, as well as enable them to obtain ours more cheaply. At the same time the value of narrow gauge roads begins once more to be discussed. It is doubtful if the narrow gauge is suitable for a trunk line which has reasonable expectations of a great and constant traffic; though there are not wanting experienced railroad men who assert that a three-foot gauge is the best for all railroads. However that may be, there is no doubt that for branch lines for railroads in sparsely settled districts and for mountainous countries the narrow gauge is the best.

But the truth is that we do not yet know all about the use and economy of the iron track. It is a tremendous machine, which we have begun to use in a crude and, as will bye-and-bye be discovered, a costly way. The economy of even the most costly railroad over such common roads as this country has, or indeed over any common road, is so great that we have hastened to extend the crude system without stopping to consider how the greatest economy might be effected. For a long time it was thought that a six-foot gauge was preferable to a four foot eight; and when the Pacific Railroad was planned there was a vigorous attempt to make that a six-foot gauge. Now, however, the Erie company will, as soon as they can borrow money to do it, narrow their gauge because they cannot compete with their rivals on other terms.

It is not probable that any important line in the country will be altered to a narrower than the present ruling gauge; but it is very likely that hereafter branch lines will be built on a three-foot or even a two-foot-and-a-half gauge, and if this system is once begun many localities may gain the great convenience and advantage of a railroad connection which are now without; for a narrow gauge road, with light iron, not intended for high speed may be run as common roads are, up and down hill, at a saving of great sums in cuttings and other engineering extravagances. The common desire to go at top speed has done much to hinder the extension of narrow gauge and economical iron tracks.

—The work at the mouth of the Mississippi was commenced by Capt. Eads on the 14th of June, and of the preliminary lines of piles, 9860 feet have now been driven on the east jetty, and 1950 on the west jetty, while 3500 feet of the mattress foundation have been securely laid. The laying of these mattress foundations goes on at the rate of 300 linear feet per day. These mattresses, 40 feet wide and two feet thick, are towed into position and fastened to the piles, and in a few hours the deposit of sediment from the current so fills the interstices as to sink them.

—The anchorage of the East river bridge is completed. Cable-making for the bridge will commence at once.

WATER SUPPLY WORKS.—The first water works in the United States were planned and constructed by Mr. John Christopher Christensen, at Bethlehem, Pa., in 1762. The machinery consisted of three single-acting force pumps, of four inch calibre and eighteen inch stroke, and worked by a triple crank, and geared to the shaft of an undershot water wheel, eighteen feet in diameter, and two feet clear in the buckets. The water was raised by this machinery to the height of seventy feet, and subsequently to 114 feet. The works, were in operation as late as 1832. The first rising main was made of gum-wood, as far as it was subject to great pressure, and the rest was of pitch-pine. In 1789 leaden pipes were substituted, and in 1813 they were changed for iron.

NEW LINE TO THE EAST.—By an arrangement between the Erie and Baltimore and Ohio railway companies a new and direct line to New York has been established and through trains will commence to run over the line Nov. 1st. The Union of these two great companies is the result of the selfish policy of Commodore Vanderbilt in excluding the Pullman car from the roads owned and controlled by him. The new route will be fully equipped with Pullman cars of the most approved pattern and finish.

### The Origin and Progress of Steam Locomotion.

The celebration of the fiftieth anniversary of the opening of the Stockton and Darlington Railway held at Darlington on the 27th and 28th of September last, suggests very strongly in the minds of most practical men, a consideration of the graduated stages of development whereby the principal factor in the railway system—the locomotive engine—has attained its present importance and perfection. It is well known that steam locomotion is no new idea, in the sense of being a production of the present century. So far back as 1759 the possibility of producing locomotion on land by steam power was suggested by a Dr. Robison, of Scotland; and James Watt patented in 1784 an application of his engine to the movements of carriages, although it never came to anything like a practical result. Trevethick completed his high-pressure locomotive engine with only one cylinder and a flywheel to secure rotary motion at the end of each stroke, in 1801; and an engine made by him was tried two years later on one of the tramways then open in Wales. Blenkinsop, in 1811, took out a patent for a locomotive engine worked by a rack or toothed rail. It was employed at the Middleton Colliery Railway, near Leeds, in 1812; and an engine of similar construction was in the following year used at the Cox Lodge Colliery Railway, on the Tyne in 1813. In this year also an engine, constructed by Chapman, was placed on the Heaton Colliery Railway, and Brunton tried on the Newbottle Railway an engine propelled by legs. Mr. Hedley's "Puffing Billy," which is now placed in the Kensington Museum, also commenced to work on the Wylam Railway in the early part of this year. This railway was a cast-iron tramroad, and Mr. Hedley, doubtful as to whether the adhesion of the wheels upon the railway was sufficient for the engine to propel itself and a load forward, made some experiments on the Wylam tramroad with a carriage made expressly for the purpose, the result being, as stated by his son, that "the friction of the wheels of the experimental carriage alone upon the rails when it approached the weight of an engine carriage, was sufficient to enable it to overcome the resistance of an attached train of carriages." In this engine the steam was passed from the cylinder into a receiver, from which again it passed into the chimney by a pipe for the purpose of preventing the noise of the injection of the steam into the chimney; and it has been said that by the operation of "this system the pipe got furred or partially choked, and when the obstruction was removed it was found that steam could not be generated so rapidly, and that to increase the supply the drivers, by means of an iron ring, contracted the orifice of the pipe, and kept it a secret for some time." Thus it is that Mr. Hedley claimed the discovery of the value of the blast in the chimney.

It was about this time that Stephenson came upon the ground with his Killingworth engines. Mr. Nicholas Wood tells us that, "soon after Stephenson had become established as engineer to the partnership collieries, in 1813, his attention was drawn to the cost of conveying the Killingworth coals by horses, where one horse only took three chaldron wagons, or about eight tons of coals, at a time. He had inspected the locomotives at Heaton and Cox Lodge, which had been abandoned, and that at Wylam, which was at work. The latter engine was working on a plate rail, and with this information of what had been done, he set to work to construct an engine. The first question was as to the adhesion of the wheels upon the round top rails, and several experiments were made by Stephenson and myself on the adhesion of such rails. Having been satisfied on this point, Stephenson discarded any extraneous assistance to propel the engine forward, such as employed by Chapman, Brunton, or Blenkinsop, simply coupling all the engine wheels together, so as to have the adhesion of the whole weight of the engine.

On July 27, 1814, the first locomotive engine which propelled itself by the adhesion of the wheels on the round top rails was tried on the Killingworth Colliery Railway. The steepest gradient on that line was 1 in 450, which it ascended with eight loaded wagons weighing altogether about 30 tons, at the rate of four miles an hour. This engine had two 8 in. cylinders with 24 in. stroke, these cylinders being let vertically into the boiler, and the piston rods carrying crossheads, from each of which a pair of side rods passed down to cranks at the end of a cross shaft. Each of these two crankshafts was geared to the axle next it, while an intermediate spur wheel geared the two crankshafts to each other. The boiler was 8 ft. long, 34 in. in diameter, and was traversed by a single straight 20 in. flue, and it was soon found that the greatest defect of the engine was the comparatively small quantity of steam generated in a given time. Hence, we are told by Mr. Nicholas Wood, the steam from the cylinder was passed into the chimney by a pipe which, as the mouth of the pipe was turned upwards, served the purpose of a blast. For the actual discovery of the application of steam blast, however, there have been numerous claimants, and the evidence bearing upon the question is too voluminous to be discussed on an occasion like the present. Respecting the several successive improvements which Stephenson made in his original Killingworth engine, Mr. Wood has told us that "cog wheels were, first of all, superseded by an endless chain, to secure the adhesion of the four wheels; next by a system of cranks with side rods. The improvements in the construction of the locomotive engine by Stephenson, over those at that period in use, viz., that of the Wylam tramroad, and Mr. Blenkinsop's at Leeds, was in the application of two cylinders, instead of one in the former engine, and in the mode or modes of communicating the action of the pistons to the driving wheels of the engine, and the application of the power of adhesion on the round top rails to propel the engine forward. The first engine on the Killingworth Railway had four three-feet driving wheels. Four-feet wheels were afterwards used, by which an increased effect was produced by the diminished friction of the working parts of the engine, and by the increased speed which was attained."

Stephenson's engine continued to be used at Killingworth Colliery until 1822, when the Stockton and Darlington Railway was in course of construction, and it became a question with Mr. Edward Pease and his colleagues in the directorate of the concern whether they should use only horses or resort to the then little known application of steam locomotion. Smiles has, in his life of Stephenson, detailed the circumstances under which that gentleman succeeded in persuading Mr. Pease to adopt the locomotive. Such a resolution having once been taken it became an important question where the locomotives could be built. There were then numerous general engineering works in the North of England where the work might have been undertaken, but it seemed to Mr. Pease that there was an opening for the construction of works specially adapted for the building of locomotive engines. In this view he was supported by his cousin, Mr. Richardson, who had made a large fortune in London as a bill broker, and these two gentlemen jointly furnished the means for the erection of the Forth-street Engine Works, at Newcastle, where the first engine used on a public railway was made under the personal supervision of Stephenson.

The two cylinders of the "Locomotion" are each 9 in. in diameter, and are placed vertically on the top of the boiler, half in and half out, each piston rod carrying a crosshead from which a pair of side rods pass down to the cranks of the corresponding pair of wheels. The crank pins of the trailing wheels carry return cranks, the pins of which are coupled to the crank pins of the leading wheels so as to keep the cranks of the leading and trailing wheels at right angles to each other. The length of stroke was 24 in. The pistons are of metal with brass rings and hemp packing. The boiler is 12 ft. long by 4 ft diameter. It has one through tupe 2 ft. in diameter and 11 ft long. At the end of this tube the firegrate is placed; and the total heating surface is only 60 square feet. The chimney is 17½ in. in diameter. The wheels are four in number and each 4 ft. in diameter. They are put together in two halves, being cast in two circles. The inner circle is wedged on with a wooden plug, and hence they were called plug

wheels. Two flat slides are worked by a loose eccentric sheave and bell cranks. The pump is 4 in. in diameter and worked from a crosshead on one of the pistons. The tender has four metal wheels, each 2 ft. 6 in. in diameter, and it has a small square tank on the top, which contains about 240 gallons of water. The feed pipes are of leather. The frame is made of wood, and very light, the total weight of the engine in working order being only 6½ tons. It was calculated that the nominal power of the engine was equal to that of sixteen horses, and the capabilities of the engine have been estimated as equal to the haulage of twelve wagons at a speed of eight miles per hour. There was no brake on this nor indeed on a number of succeeding engines, used on the Stockton and Darlington Railway, and it was not an easy matter to bring it to a stop. After it had been employed on the Stockton and Darlington Railway till 1850, "Locomotion No. 1" was acquired by the Messrs Pease's West Collieries in South Durham, where it pumped water until 1857, and in the latter year it was taken back to Darlington, and placed on a pedestal in front of the railway station in that town, where it has since stood, an object of interest and curiosity to all who travel on the first public railway on which steam locomotion was employed. The preservation of old "Locomotion" is a matter of congratulation, inasmuch as the Exhibition of Engines held at the North-road Engine Works during the present week would have lost much of its attraction had this parent locomotive been absent.

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| | ft. | in. |
|---|---|---|
| Diameter of cylinder | 0 | 8 |
| Length of stroke | 1 | 4½ |
| Number of wheels (not coupled) | 0 | 4 |
| Diameter of driving wheels | 4 | 8½ |
| Diameter of boiler | 3 | 4 |
| Length of barrel | 6 | 0 |
| Length of firebox inside | 2 | 0 |
| Width of firebox inside | 3 | 0 |
| Height of firebox inside | 3 | 0 |
| Number of tubes | 25 | |
| Diameter of tubes | 0 | 3 |

| | sq. ft. |
|---|---|
| Heating surface: firebox | 20 |
| " tubes | 117¾ |
| Total | 137¾ |
| Firegrate area | 6 |
| Pressure of steam | 50 lbs. |
| Weight of engine | 4¼ tons. |

The next engines we have to notice are those of the "Wilberforce" class, designed by Timothy Hackworth. The "Wilberforce" was built by R. and W. Hawthorn, of Newcastle, in 1832, for the Stockton and Darlington Railway Company. It had three straight axles, each 4½ in. in diameter, and one hind axle with two cranks keyed on to it. The boiler was 9 ft. 6 in. long by 4 ft. diameter. The cylinders were 14¾ in. in diameter and the length of stroke was 16 in., the cylinders being fixed outside and placed vertically above the hind axle. The chimney was 15 in. in diameter at the bottom and 13 in. at the top, the length being 5 ft. 9 in. The flue was 7 ft. 9 in. long and 2 ft. 6 in. by 2 ft. 2 in., and there were 107 iron tubes each 7 ft. 6 in. long by 1¾ in. in diameter. The valve gear consisted of eccentrics and gabs working vertically above the hind axle. There were six metal rim and centre wheels, each 4 ft. in diameter, and the tyres were 1⅞ in. thick and 5 in. broad. The pistons were of metal with metal packing rings. The tender tank was a barrel made of wood and capable of holding 616 gallons of water. The brake gear consisted of a long lever with adjusting screws and four wood breasts.

In the same year that the "Wilberforce" was built, Hackworth designed the "Darlington," which was also built at Hawthorn's works at Newcastle. This engine had three straight axles, each 4½ in. in diameter and a hind axle 4½ in. in diameter with two malleable iron cranks keyed on to it. The boiler was 9 ft. 6 in. long and 4 ft. 4 in. in diameter. The cylinders were 14¾ in. diameter, and were fixed vertically to the frame from the end of the boiler, the length of stroke being 16 in. The chimney was 15 in. in diameter at bottom and 13 in. at the top, its length being 1 ft. 1½ in. The boiler was fitted with 88 brass and copper tubes, each 7 ft. 7 in. long and 1¾ in. in diameter. The valve gear consisted of eccentrics and gabs, working vertically at the end of the boiler. The six wheels were of metal, each 4 ft. in diameter with Lowmoor tyres 1⅞ in. thick by 5 in. broad. The wood barrel of the tender held 519 gallons of water. The tender was of wood and carried about one ton of coal. It had four cast-iron wheels with Bishopwearmouth tyres and was mounted on springs.

The "Arrow" is another notable engine which was built by Timothy Hackworth, at his own Soho Works at Shildon in 1837. This engine had a leading axle 4½ in. diameter, a crank axle 6 in. in diameter, and a trailing axle 4¾ in. in diameter. The boiler was 7 ft. 9 in. long, and 3 ft. 4 in. in diameter, and there were two cylinders, each 9 in. in diameter, placed horizontally, and having a stroke of 21 in. The firebox was of copper, 2 ft. 7½ in. long, 3 ft. 6 in. broad, and 4 ft. 2 in. high above the firebars. The boiler contained 133 tubes, 8 ft. 2 in. long and 1⅝ in. in diameter. The engine had one pair of driving wheels, 5 ft. in diameter, having spokes of round malleable iron, naves of cast iron, and tyres 1⅞ in. thick, and 5 in. broad, and two leading and two trailing wheels of the same description. The tender tank was made of sheet iron, and capable of holding 645 gallons. The tender was furnished with malleable iron horns, springs, wooden buffers, and a screw brake with adjusting screws.

The "Queen" was constructed by Alfred Kitching, of Darlington, in 1838. It had leading and trailing axles 4 7/16 in. in diameter and a crank axle 5¾ in. in diameter. The boiler was 8 ft. 6 in. long by 3 ft. 8 in. in diameter, and there were two

cylinders, each 14⅛ in. in diameter, and fixed obliquely inside of the frame. The length of stroke was 17⅞ in. The firebox was of copper, 2 ft. 7 in. long, and 3 ft. 6 in. broad by 4 ft. 5 in. high above the firebars. The boiler contained 86 copper tubes 8 ft. 10 in. long and 2 in. in diameter. The engine was fitted with expansion links, and had four driving wheels, each 4 ft. 6 in. in diameter. The feed pipes were telescopic, made of brass and iron. The tender tank was made of sheet iron, and capable of holding 654 gallons of water. It was carried on a wood frame with horns of malleable iron, with four malleable iron wheels, having axles 3½ in. in diameter in the middle. The tender was mounted on four springs, and was provided with a screw brake.

In the following year (1839) the Stockton and Darlington Railway Company ordered the building of the "London" by Messrs Hague and Company, and the engine is worthy of note as the first which the company had built out of the North of England. The "London" may be regarded as one of the very first locomotives constructed in the metropolis for a northern railway. It had four coupled wheels 4 ft. 5 in. in diameter, the leading axle being $4\frac{5}{8}$ in. in diameter and the crank axle 5 in. in diameter. The boiler was 7 ft. long by 2 ft. 4 in. in diameter, and the firebox was of copper, shaped thus D, and was 2 ft. 7½ in. long by 3 ft. 3 in. broad, and 3 ft. 7 in. high above the firebars. It contained 71 copper and brass tubes, each 7 ft. 4 in. long and 1¾ in. in diameter. The engine had cylinders 11 in. in diameter with 16 in. stroke, and was fitted with gab motion. The tender was of sheet iron and capable of holding 491 gallons of water. It had four cast-iron wheels each 2 ft. 10½ in. in diameter, four buffers, four springs, and the brake was a long lever with two wooden blocks.

We have given the leading particulars of the engines above mentioned because they belonged to types which were not represented at the exhibition of locomotives held at Darlington on Monday and Tuesday last. Of the latter engines we shall speak hereafter when dealing with the exhibition; in the mean time, however, we propose to say something respecting the earlier rolling stock and permanent way.

### The First Wagons and Permanent Way.

To the readers of a journal like ours, the first gropings after mechanical needs, and the graduated stages by which those needs were supplied, at first very imperfectly, may be even more interesting than statistical or historical memorabilia. It was never intended at the outset of the Stockton and Darlington Railway that it should be other than a tramway designed for the purpose of carrying coals and other merchandize from the interior of South Durham to the sea-board, and the immediate centres of population. At that time, indeed, the South Durham coalfield, which now sends out its 18,000,000 tons of coal per annum, was completely isolated from the rest of the world, and the produce as a whole was considerably under a million tons. It was at first a moot point whether a canal should not be constructed in preference to a railway, but it was eventually decided that the latter should be adopted, the estimated cost of the canal being 205,283*l.* as compared with 125,000*l.* for the railway. The first work of constructing a public railway was not easy. Not many men then living could have carried it out as Stephenson did. He had more experience of railways than any other man in the North of England, and he had just completed the Hetton Colliery Railway, in 1822. In the construction of the line he adopted the following principles:

"1. On the level, or nearly level gradients, horses or locomotive engines were proposed to be used, it being laid down as a rule that, if practicable, the gradients, ascending with the load, should not be more than 1 in 100.

"2. In gradients descending with the load, when more than 1 in 30, the use of self-acting planes; and—

"3. In ascending gradients with the load, where the gradients did not admit of the use of horses or locomotive engines, fixed engines and ropes should be adopted."

In the application of these rules to the Stockton and Darlington Railway, Stephenson employed a fixed engine on the line to pull coals over Brusselton Hill, a steep elevation above Shildon, where, on his advice, two 30-horse power engines, acting on one shaft, were erected by R. Stephenson and Company, of Newcastle, for drawing the wagons up the incline. The cost of these engines was 3482*l.* 15s. At the Etherly Hill top, two other engines were erected, each of 15-horse power and acting on one shaft, at a cost of 1682*l.* 15s. The contract for the construction of these engines provided that the builders "should find every description of material, and all fitting up for both engines and boilers, except that the company shall find all the stones in the rough state that may be wanted for the said purpose at Brusselton or Etherly quarries, we leading the said stones—the two boilers for the first-named engine to be 8 ft. diameter by 20 ft. long, and the boiler for the Etherly engine to be of the same dimensions, and to be made of the best scrap iron. . . . The size of the working cylinders to be 30 in. for the Brusselton engine, and 22 in. for the Etherly engine, and all other materials to be in proportion and of the best quality and workmanship, fitted up in a complete and workmanlike manner."

One of the greatest difficulties that occurred to the directors of the Stockton and Darlington Railway arose out of the consideration of the wagons that ought to be allowed to run on the line. They were met by all kinds of applications for leave to use wagons, carts, lorries, and conveyances of different sorts and sizes. Confusion and disorder were certain in the long run to arise out of such a miscellaneous and unmethodical arrangement, and hence the company laid down the following conditions for the construction of wagons to be used on the line: That the soles, if of English oak, should be 7 in. by 5 in.; that the bottom sheaths, if of English oak, should be four in number, two of them measuring 9 in. by 4 in., and the other two 6 in. by 4 in., an inch more in each sheath being required if made of other timber; that the height from the top of the rail to the underside of the cleat, or lining affixed to the bottom side of the sole ends, should not exceed 1 ft. 7 in.; that the height from the top of the rail to the bottom should not exceed 1 ft. 8 in.; that the coupling chains should be made of 1 in. round iron, and that protecting or side chains be fixed to the wagons; that the end link should be 3½ in. long, and the rest of the links 2½ in. long; that the bottom part should be 3½ in. broad and 1⅛ in. thick to the first bolt-hole in the sheath; that the pin hole should be 1¼ in. in diameter, and 1½ in. from the end of the bar; that the coupling chain pin should be 5¾ in. long from the shoulder, 1⅛ in. thick at the shoulder, and 1¼ in. thick at the point; that the drawing strap and crook should be made of 1-in. round iron; that the journals and axles should not be less than 3 in. in diameter; that the wheels should not be less diameter than 2 ft. 6 in., nor to exceed 2 ft. 10 in., exclusive of the flange; that the weight of the wheels should be not less than 2¼ cwt., nor to exceed 2¾ cwt.; that the brake handles be of 1¼ in. round iron; that the bottom bands be 1⅜ in. square; and that the whole of the ironwork specified should be made of best scrap bars. A penalty was attached to bringing any wagon on the line not constructed in accordance with these requirements. All wagons used on the line, and indeed on all lines in the North of England for many years subsequent to this date, were called chaldron wagons, and carried from 2 to 3 tons. Of these there are still over 7000 in use on the Darlington section. The wooden hopper wagons were introduced on the line in 1860, and

| | | | |
|---|---|---|---|
| | In 1863 there were | 1,075 | in use |
| To which in | 1864 | 522 | added. |
| " | 1865 | 725 | " |
| " | 1866 | 647 | " |
| " | 1867 | 450 | " |
| " | 1868 | 256 | " |
| " | 1869 | 374 | " |
| " | 1870 | 1,460 | " |
| " | 1871 | 1,526 | " |
| " | 1872 | 1,293 | " |
| " | 1873 | 1,743 | " |
| And in | 1874 | 1,456 | " |
| | Total now running | 11,527 | |

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wheels. Two flat slides are worked by a loose eccentric sheave and bell cranks. The pump is 4 in. in diameter and worked from a crosshead on one of the pistons. The tender has four metal wheels, each 2 ft. 6 in. in diameter, and it has a small square tank on the top, which contains about 240 gallons of water. The feed pipes are of leather. The frame is made of wood, and very light, the total weight of the engine in working order being only 6½ tons. It was calculated that the nominal power of the engine was equal to that of sixteen horses, and the capabilities of the engine have been estimated as equal to the haulage of twelve wagons at a speed of eight miles per hour. There was no brake on this nor indeed on a number of succeeding engines, used on the Stockton and Darlington Railway, and it was not an easy matter to bring it to a stop. After it had been employed on the Stockton and Darlington Railway till 1850, "Locomotion No. 1" was acquired by the Messrs Pease's West Collieries in South Durham, where it pumped water until 1857, and in the latter year it was taken back to Darlington, and placed on a pedestal in front of the railway station in that town, where it has since stood, an object of interest and curiosity to all who travel on the first public railway on which steam locomotion was employed. The preservation of old "Locomotion" is a matter of congratulation, inasmuch as the Exhibition of Engines held at the North-road Engine Works during the present week would have lost much of its attraction had this parent locomotive been absent.

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| Length of firebox inside | |
| Width of firebox inside | |
| Height of firebox inside | |
| Number of tubes - | |
| Diameter of tubes | |
| Heating surface: fire | |
| " tub | |
| Total - - | |
| Firegrate area - | |
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The next engines we have to notice are those of the "Wilberforce" class, designed by Timothy Hackworth. The "Wilberforce" was built by R. and W. Hawthorn, of Newcastle, in 1832, for the Stockton and Darlington Railway Company. It had three straight axles, each 4½ in. in diameter, and one hind axle with two cranks keyed on to it. The boiler was 9 ft. 6 in. long by 4 ft. diameter. The cylinders were 14¾ in. in diameter and the length of stroke was 16 in., the cylinders being fixed outside and placed vertically above the hind axle. The chimney was 15 in. in diameter at the bottom and 13 in. at the top, the length being 5 ft. 9 in. The flue was 7 ft. 9 in. long and 2 ft. 6 in. by 2 ft. 2 in., and there were 107 iron tubes each 7 ft. 6 in. long by 1¾ in. in diameter. The valve gear consisted of eccentrics and gabs working vertically above the hind axle. There were six metal rim and centre wheels, each 4 ft. in diameter, and the tyres were 1⅞ in. thick and 5 in. broad. The pistons were of metal with metal packing rings. The tender tank was a barrel made of wood and capable of holding 616 gallons of water. The brake gear consisted of a long lever with adjusting screws and four wood breasts.

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|---|---|---|---|
| In | 1863 | there were | 1,075 in use |
| To which in | 1864 | " | 522 added. |
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| Total now running | | | 11,527 |

The iron hopper wagons were intro-

wheels. Two flat slides are worked by a loose eccentric sheave and bell cranks. The pump is 4 in. in diameter and worked from a crosshead on one of the pistons. The tender has four metal wheels, each 2 ft. 6 in. in diameter, and it has a small square tank on the top, which contains about 240 gallons of water. The feed pipes are of leather. The frame is made of wood, and very light, the total weight of the engine in working order being only 6½ tons. It was calculated that the nominal power of the engine was equal to that of sixteen horses, and the capabilities of the engine have been estimated as equal to the haulage of twelve wagons at a speed of eight miles per hour. There was no brake on this nor indeed on a number of succeeding engines, used on the Stockton and Darlington Railway, and it was not an easy matter to bring it to a stop. After it had been employed on the Stockton and Darlington Railway till 1850, "Locomotion No. 1" was acquired by the Messrs Pease's West Collieries in South Durham, where it pumped water until 1857, and in the latter year it was taken back to Darlington, and placed on a pedestal in front of the railway station in that town, where it has since stood, an object of interest and curiosity to all who travel on the first public railway on which steam locomotion was employed. The preservation of old "Locomotion" is a matter of congratulation, inasmuch as the Exhibition of Engines held at the North-road Engine Works during the present week would have lost much of its attraction had this parent locomotive been absent.

From 1825 till 1830, eleven new engines were built for the Stockton and Darlington Railway, mostly with the same structural features as the No. 1 engine. But in those five years considerable improvements had been made in the locomotive. Timothy Hackworth, who came on to the Stockton and Darlington Railway in 1825, to undertake the superintendence of the locomotives, was an engineer of great inventive capacity, and Mr. D. K. Clark, in his history of the locomotive engine, has justly said that up to the year 1830, no one did more than he for its establishment as a permanent railway motor. One of the first improvements which he introduced was the application on a more perfect scale than had previously been achieved of the steam blast. The "Royal George," built in 1827, was the first engine to which Hackworth applied the steam blast. This engine commenced to work on the Stockton and Darlington Railway in October, 1827, and it has been justly described as "the first really efficient locomotive." It had a pair of 11-in. cylinders with 20 in. stroke, placed vertically over the leading wheels, and was mounted on six coupled wheels, each of 4 ft. diameter. The boiler was 13 ft. long by 52in. in diameter, and was fitted with a horse-shoe or return flue, whereby the engine was enabled to generate steam more quickly than any of her predecessors. It was equal to hauling twenty-eight wagons at the rate of nine miles per hour. It is really wonderful how perfectly this engine was made when the difficulties of its construction are taken in to account. The "Royal George" was built at the first locomotive works at Shildon, which commenced with two blacksmith's fires, and a shed sufficient only to hold two engines of the size of the "Locomotion," and when in 1827 the "Royal George" was built, the accommodation was very little larger. It is to be regretted that the "Royal George," with its many interesting reminiscences, was not available for the purpose ol the exhibition which was this week held at Darlington. A similar regret may be expressed with reference to the "Sans Pareil," the next engine which Hackworth built at Shildon. It is now a matter of history that the "Sans Pareil" was defeated in the Rainhill locomotive competition, in which it took part in 1829, but it was afterwards sold to the Bolton Railway Company, and was employed on their line for a number of years. Although the "Rocket," the winner of the Rainhill competition, is not connected with the history of the Stockton and Darlington line, yet, as the first locomotive provided with the multitubular boiler, it may be of interest to give its principal dimensions, so that they may be compared with those of the other early locomotives of which we have to speak. They are as follows :

| | ft. | in. |
|---|---|---|
| Diameter of cylinder | 0 | 8 |
| Length of stroke | 1 | 4½ |
| Number of wheels (not coupled) | 0 | 4 |
| Diameter of driving wheels | 4 | 8½ |
| Diameter of boiler | 3 | 4 |
| Length of barrel | 6 | 0 |
| Length of firebox inside | 2 | 0 |
| Width of firebox inside | 3 | 0 |
| Height of firebox inside | 3 | 0 |
| Number of tubes | 25 | |
| Diameter of tubes | 0 | 3 |

| | sq. ft. |
|---|---|
| Heating surface: firebox | 20 |
| " tubes | 117¾ |
| Total | 137¾ |
| Firegrate area | 6 |
| Pressure of steam | 50 lbs. |
| Weight of engine | 4¼ tons. |

The next engines we have to notice are those of the "Wilberforce" class, designed by Timothy Hackworth. The "Wilberforce" was built by R. and W. Hawthorn, of Newcastle, in 1832, for the Stockton and Darlington Railway Company. It had three straight axles, each 4½ in. in diameter, and one hind axle with two cranks keyed on to it. The boiler was 9 ft. 6 in. long by 4 ft. diameter. The cylinders were 14¾ in. in diameter and the length of stroke was 16 in., the cylinders being fixed outside and placed vertically above the hind axle. The chimney was 15 in. in diameter at the bottom and 13 in. at the top, the length being 5 ft. 9 in. The flue was 7 ft. 9 in. long and 2 ft. 6 in. by 2 ft. 2 in., and there were 107 iron tubes each 7 ft. 6 in. long by 1¾ in. in diameter. The valve gear consisted of eccentrics and gabs working vertically above the hind axle. There were six metal rim and centre wheels, each 4 ft. in diameter, and the tyres were 1⅞ in. thick and 5 in. broad. The pistons were of metal with metal packing rings. The tender tank was a barrel made of wood and capable of holding 616 gallons of water. The brake gear consisted of a long lever with adjusting screws and four wood breasts.

In the same year that the "Wilberforce" was built, Hackworth designed the "Darlington," which was also built at Hawthorn's works at Newcastle. This engine had three straight axles, each 4½ in. in diameter and a hind axle 4½ in. in diameter with two malleable iron cranks keyed on to it. The boiler was 9 ft. 6 in. long and 4 ft. 4 in. in diameter. The cylinders were 14¾ in. diameter, and were fixed vertically to the frame from the end of the boiler, the length of stroke being 16 in. The chimney was 15 in. in diameter at bottom and 13 in. at the top, its length being 1 ft. 1½ in. The boiler was fitted with 88 brass and copper tubes, each 7 ft. 7 in. long and 1¾ in. in diameter. The valve gear consisted of eccentrics and gabs, working vertically at the end of the boiler. The six wheels were of metal, each 4 ft. in diameter with Lowmoor tyres 1⅞ in. thick by 5 in. broad. The wood barrel of the tender held 519 gallons of water. The tender was of wood and carried about one ton of coal. It had four cast-iron wheels with Bishopwearmouth tyres and was mounted on springs.

The "Arrow" is another notable engine which was built by Timothy Hackworth, at his own Soho Works at Shildon in 1837. This engine had a leading axle 4½ in. diameter, a crank axle 6 in. in diameter, and a trailing axle 4¾ in. in diameter. The boiler was 7 ft. 9 in. long, and 3 ft. 4 in. in diameter, and there were two cylinders, each 9 in. in diameter, placed horizontally, and having a stroke of 21 in. The firebox was of copper, 2 ft. 7½ in. long, 3 ft. 6 in. broad, and 4 ft. 2 in. high above the firebars. The boiler contained 133 tubes, 8 ft. 2 in. long and 1⅝ in. in diameter. The engine had one pair of driving wheels, 5 ft. in diameter, having spokes of round malleable iron, naves of cast iron, and tyres 1⅞ in. thick, and 5 in. broad, and two leading and two trailing wheels of the same description. The tender tank was made of sheet iron, and capable of holding 645 gallons. The tender was furnished with malleable iron horns, springs, wooden buffers, and a screw brake with adjusting screws.

The "Queen" was constructed by Alfred Kitching, of Darlington, in 1838. It had leading and trailing axles 4⅞ in. in diameter and a crank axle 5¾ in. in diameter. The boiler was 8 ft. 6 in. long by 3 ft. 8 in. in diameter, and there were two

cylinders, each 14⅛ in. in diameter, and fixed obliquely inside of the frame. The length of stroke was 17⅞ in. The firebox was of copper, 2 ft. 7 in. long, and 3 ft. 6 in. broad by 4 ft. 5 in. high above the firebars. The boiler contained 86 copper tubes 8 ft. 10 in. long and 2 in. in diameter. The engine was fitted with expansion links, and had four driving wheels, each 4 ft. 6 in. in diameter. The feed pipes were telescopic, made of brass and iron. The tender tank was made of sheet iron, and capable of holding 654 gallons of water. It was carried on a wood frame with horns of malleable iron, with four malleable iron wheels, having axles 3½ in. in diameter in the middle. The tender was mounted on four springs, and was provided with a screw brake.

In the following year (1839) the Stockton and Darlington Railway Company ordered the building of the "London" by Messrs Hague and Company, and the engine is worthy of note as the first which the company had built out of the North of England. The "London" may be regarded as one of the very first locomotives constructed in the metropolis for a northern railway. It had four coupled wheels 4 ft. 5 in. in diameter, the leading axle being $4\frac{6}{16}$ in. in diameter and the crank axle 5 in. in diameter. The boiler was 7 ft. long by 2 ft. 4 in. in diameter, and the firebox was of copper, shaped thus D, and was 2 ft. 7½ in. long by 3 ft. 3 in. broad, and 3 ft. 7 in. high above the firebars. It contained 71 copper and brass tubes, each 7 ft. 4 in. long and 1¾ in. in diameter. The engine had cylinders 11 in. in diameter with 16 in. stroke, and was fitted with gab motion. The tender was of sheet iron and capable of holding 491 gallons of water. It had four cast-iron wheels each 2 ft. 10½ in. in diameter, four buffers, four springs, and the brake was a long lever with two wooden blocks.

We have given the leading particulars of the engines above mentioned because they belonged to types which were not represented at the exhibition of locomotives held at Darlington on Monday and Tuesday last. Of the latter engines we shall speak hereafter when dealing with the exhibition; in the mean time, however, we propose to say something respecting the earlier rolling stock and permanent way.

### The First Wagons and Permanent Way.

To the readers of a journal like ours, the first gropings after mechanical needs, and the graduated stages by which those needs were supplied, at first very imperfectly, may be even more interesting than statistical or historical memorabilia. It was never intended at the outset of the Stockton and Darlington Railway that it should be other than a tramway designed for the purpose of carrying coals and other merchandize from the interior of South Durham to the sea-board, and the immediate centres of population. At that time, indeed, the South Durham coalfield, which now sends out its 18,000,000 tons of coal per annum, was completely isolated from the rest of the world, and the produce as a whole was considerably under a million tons. It was at first a moot point whether a canal should not be constructed in preference to a railway, but it was eventually decided that the latter should be adopted, the estimated cost of the canal being 205,283*l.* as compared with 125,000*l.* for the railway. The first work of constructing a public railway was not easy. Not many men then living could have carried it out as Stephenson did. He had more experience of railways than any other man in the North of England, and he had just completed the Hetton Colliery Railway, in 1822. In the construction of the line he adopted the following principles:

"1. On the level, or nearly level gradients, horses or locomotive engines were proposed to be used, it being laid down as a rule that, if practicable, the gradients, ascending with the load, should not be more than 1 in 100.

"2. In gradients descending with the load, when more than 1 in 30, the use of self-acting planes; and—

"3. In ascending gradients with the load, where the gradients did not admit of the use of horses or locomotive engines, fixed engines and ropes should be adopted."

In the application of these rules to the Stockton and Darlington Railway, Stephenson employed a fixed engine on the line to pull coals over Brusselton Hill, a steep elevation above Shildon, where, on his advice, two 30-horse power engines, acting on one shaft, were erected by R. Stephenson and Company, of Newcastle, for drawing the wagons up the incline. The cost of these engines was 3482*l.* 15s. At the Etherly Hill top, two other engines were erected, each of 15-horse power and acting on one shaft, at a cost of 1682*l.* 15s. The contract for the construction of these engines provided that the builders "should find every description of material, and all fitting up for both engines and boilers, except that the company shall find all the stones in the rough state that may be wanted for the said purpose at Brusselton or Etherly quarries, we leading the said stones—the two boilers for the first-named engine to be 8 ft. diameter by 20 ft. long, and the boiler for the Etherly engine to be of the same dimensions, and to be made of the best scrap iron. . . . The size of the working cylinders to be 30 in. for the Brusselton engine, and 22 in. for the Etherly engine, and all other materials to be in proportion and of the best quality and workmanship, fitted up in a complete and workmanlike manner."

One of the greatest difficulties that occurred to the directors of the Stockton and Darlington Railway arose out of the consideration of the wagons that ought to be allowed to run on the line. They were met by all kinds of applications for leave to use wagons, carts, lorries, and conveyances of different sorts and sizes. Confusion and disorder were certain in the long run to arise out of such a miscellaneous and unmethodical arrangement, and hence the company laid down the following conditions for the construction of wagons to be used on the line: That the soles, if of English oak, should be 7 in. by 5 in.; that the bottom sheaths, if of English oak, should be four in number, two of them measuring 9 in. by 4 in., and the other two 6 in. by 4 in., an inch more in each sheath being required if made of other timber; that the height from the top of the rail to the underside of the cleat, or lining affixed to the bottom side of the sole ends, should not exceed 1 ft. 7 in.; that the height from the top of the rail to the bottom should not exceed 1 ft. 8 in.; that the coupling chains should be made of 1 in. round iron, and that protecting or side chains be fixed to the wagons; that the end link should be 3½ in. long, and the rest of the links 2½ in. long; that the bottom part should be 3½ in. broad and 1⅛ in. thick to the first bolt-hole in the sheath; that the pin hole should be 1¼ in. in diameter, and 1½ in. from the end of the bar; that the coupling chain pin should be 5¾ in. long from the shoulder, 1⅛ in. thick at the shoulder, and 1¼ in. thick at the point; that the drawing strap and crook should be made of 1-in. round iron; that the journals and axles should not be less than 3 in. in diameter; that the wheels should not be less diameter than 2 ft. 6 in., nor to exceed 2 ft. 10 in., exclusive of the flange; that the weight of the wheels should be not less than 2¼ cwt., nor to exceed 2¾ cwt.; that the brake handles be of 1¼ in. round iron; that the bottom bands be 1⅜ in. square; and that the whole of the ironwork specified should be made of best scrap bars. A penalty was attached to bringing any wagon on the line not constructed in accordance with these requirements. All wagons used on the line, and indeed on all lines in the North of England for many years subsequent to this date, were called chaldron wagons, and carried from 2 to 3 tons. Of these there are still over 7000 in use on the Darlington section. The wooden hopper wagons were introduced on the line in 1860, and

| | | | |
|---|---|---|---|
| In 1863 there were | | 1,075 | in use |
| To which in 1864 | " | 522 | added. |
| " 1865 | " | 725 | " |
| " 1866 | " | 647 | " |
| " 1867 | " | 450 | " |
| " 1868 | " | 256 | " |
| " 1869 | " | 374 | " |
| " 1870 | " | 1,460 | " |
| " 1871 | " | 1,526 | " |
| " 1872 | | 1,293 | " |
| " 1873 | " | 1,743 | " |
| And in 1874 | " | 1 456 | " |
| Total now running | | 11.527 | |

The iron hopper wagons were intro-

duced on the Stockton and Darlington section in 1856, when forty were in use.

| | | | | |
|---|---|---|---|---|
| To which in | 1857 | there were | 262 | added. |
| " | 1860 | " | 61 | " |
| " | 1861 | " | 339 | " |
| " | 1862 | " | 56 | " |
| " | 1863 | " | 294 | " |
| " | 1865 | " | 102 | " |
| " | 1866 | " | 400 | " |
| " | 1867 | " | 3 | " |
| Total now running | | | 1,557 | |

The coke wagons now employed on this line vary in capacity from 5 to 10 tons, and their number is increasing every year. So much for the results that have followed from the 150 chaldron wagons with which the line was started fifty years ago.

Another matter that greatly perplexed the directors of the Stockton and Darlington line in 1822 was the kind of rails that should be adopted. Stephenson recommended malleable iron rails, 28 lb. per yard, "fish bellied," and Birkenshaw's patent, and the directors, after consulting several other engineers, recommended that two-thirds of the lines should be laid with malleable iron and the remainder with cast iron, the chairs in both cases to be of cast iron. The following are the conditions which the company issued for their supply :

"1. The proposals to specify the lowest price, as there will not be an opportunity of making any abatement.

"2. No tender will be considered unless made by the principal or accredited agent, nor should it differ in any respect from these conditions and specifications.

"3. The party contracting for malleable or cast iron rails should give a bond in the penalty of 4000*l.* for the fulfilment of his contract, according to specifications.

"4. The party contracting for chairs to give a bond in a penalty of 5000*l.* for the fulfilment of his contract according to specifications.

"5. The rails of malleable iron to be made from scraps or good English bars re-manufactured—the railway company to have the liberty of sending an occasional inspector to see that the rails and chairs are made of materials according to agreement.

"6. The rails, whether malleable or cast iron, and the chairs for the same, to be tested as laid down, by a weight of fourteen tons, placed on a four-wheeled carriage, coupled at a distance of four feet, and moving at the rate of two and a half miles per hour.

"7. All rails, of either description, and all chairs, which shall be broken on testing by the above weight, or which at any time within three years after being laid down, shall have any apparent deficiency, shall be returned to the contractor, who shall bear the expenses of all carriage, and supply others to the railway company free from any charge.

"8. The engineer employed by the railway company shall, at their expense, lay down one hundred yards of malleable iron rails, and one hundred yards of cast-iron rails to prove that the specific weight of the rails is sufficient to bear the above described weight."

It was specified that the malleable iron rails shonld be 56 lb. per double yard ; that the breadth of top of rail should be 2¼ in., and the depth at the end 2 in. ; that the depth at the middle should be 3¼ in. ; that the depth of the top flange should be ¾ in. ; that the thickness of the web at the top should be ¾ in. ; that the thickness of the web at the bottom should be ½ in. ; that the edge should be rounded and the surface flat ; that the rails should be perfectly straight, and fit to the chairs accurately ; and that a sample rail and chair, or patterns thereof, should be furnished to the company. With reference to the cast-iron rails it was provided that the length of each should be 4 ft., and that the weight per double yard should be 115 lbs.—the breadth at the top of the rail to be 2¼ in. ; the depth at the end to be 4 in. ; the depth at the middle to be 6 in. ; the depth of the top flange to be an inch, and the thickness of the web at the top to be ⅝ in. The cast-iron chairs for the malleable iron rails were required to be 12 lbs. per double yard, each chair weighing 6 lbs. ; and for the cast-iron rails the chairs were required to be 10 lbs. each or 15 lbs. per double yard.

It is utterly impossible to contemplate the remarkable difficulties with which the pioneers of the first public railway had to contend without feeling that much greater credit is due to their efforts than posterity, in all probability, will ever be disposed to allow. Everything about the Stockton and Darlington Railway was more or less experimental. The directors resolved by an admixture of cast and malleable iron rails, to decide for themselves, by the lessons of experience, which was the most economical. But this was not all. They were quite at a loss to dlscover how the rails were to be attached to the way. Sleepers such as those now universally used were then altogether unknown. In one or two tramways in Wales and elsewhere oak blocks had been laid down. But the directors seemed to think that stone blocks would be more durable and more firm than timber, and hence they determined to lay the greater part of the line with them. These blocks were obtained from Brussleton Bank incline ; and it is a somewhat curious fact that the line was taken further south than it otherwise would have been, in order that it might be brought as near as possible to these quarries, and thus cheapen the cost of the blocks. These blocks cost 3s. 6d. each in wagons at the quarries, or about 6s. 6d. per lineal yard, when drilled and laid down. They were 18 in. to 24 in. long by 14 in. to 18 in. broad, and 10 in. to 12 in. deep, "the top and bottom of each block to be parallel with each other." Into one of the parallel sides of the stone block, and exactly in the centre, the contractor was required to insert the cast-iron chair to the depth of half an inch. Two holes, each three quarters of an inch in depth, were drilled through each block to correspond with those of the chair. The oak blocks used in the construction of the original Stockton and Darlington line in 1822-23 were 2 ft. 6 in. long, 6 in. broad, and 6 in. to 8 in. deep. The first switches used on the line were 4 ft. in length and made of cast-iron, with wrought iron tongues. The cost of maintenance in the earlier years of the Stockton aed Darlington Railway was terrific. Owing to the extreme rigidity of the stone blocks, the rolling stock was nearly shaken to pieces, and the permanent way was much damaged—so much so, indeed, that neither could stand one halt of the wear and tear they now endure under more favorable conditions. Nor was this a feature confined to the first public railway. It applied quite as much to the line from Darlington to York and the Grand Juncton and London and Birmingham lines, on each of which stone blocks were at first employed, although they soon came to be superseded by the modern sleeper.—[Engineering.

### The Highest Signal in the World.

A new surveying signal has lately been erected on the summit of Mount Shasta, California, by the Coast Survey Department. The signal is a hollow cylinder of galvanized iron, twelve feet high and two and a half feet in diameter, surrounded by a cone of nickel plated copper, with concave sides, three feet high and three feet in diameter at the base ; and its altitude is, according to the observations taken by the members of the Coast Survey, 14,402 feet. The nickel plating of the signal is a brilliant reflector, and will, from 6 to 9 A. M., and from 3 to 7 P. M., reflect the sunlight in such a manner that the reflection can be seen from the valleys and the mountains from which the summit of the mountain is visible. It is believed that it can be used for observations at a distance of one hundred miles, and possibly further.

### Long Rails.

During the recent celebration at Darlington of the fiftieth anniversary of the opening of the first passenger railway, the Britannia Iron Works Company, at their works at the neighboring town of Middlesborough, rolled for the inspection of visitors some rails of unprecedented length, and it is proposed to place one of them, 130 feet long, near the first locomotive engine. opposite the Darlington station, as a memorial of the jubilee. During the same week this company rolled in one mill, 1,350 tons of rails 40 lbs. per yard, a quantity which it is believed has never been even approached in any other mill in the same space of time. The rails were for the New Zealand Government Railways.

Notwithstanding the dullness prevailing in trade circles, some special industries ars fully employed. The Globe Nails Co., Boston, Mas., are turning out about five tons of horse nails every ten hours, and even at this rapid rate of production they find themselves unable to catch up with their orders. They contemplate increasing their facilities by the addition of new machinery at an early day.

Only 34 tons of steel rails were shipped from England to this country last month.

## Principles of a Water Supply.

BY AN AMERICAN ENGINEER.

Nearly all the large cities in the northern and western states of America, and the Canadas, and a great number of the smaller cities and towns, have constructed efficient waterworks for bringing in an abundant supply of good water to the streets and houses. These works are all on the constant supply system, and none other would be tolerated in America. The expense of constructing the works has generally been borne by the municipalities, by whom the works are also managed. The quantity of water furnished by these works varies from 30 to 70 gallons per day for each inhabitant, which includes the water for watering the streets, extinguishing fires, for public fountains, for flushing the sewers, and for manufacturing purposes. The water used for domestic purposes alone does not exceed 20 gallons per day for each inhabitant, and in those cities where the consumption reaches 60 or 70 gallons, it is believed that at least one-third is wasted by defective household service pipes and cocks, or by wanton waste. Wherever meters have been applied, the waste has been reduced to the above extent.

The extent of ground necessary to catch the rain required to supply a town with water is much less than is generally supposed, and does not usually exceed that on which the town stands. Of course, this rule will vary with the rainfall, for in some countries there is hardly any rain at all, and in other countries the fall is excessive. But it will hold good for most parts of England and other similar countries. Thus, if we suppose London to contain a population of three millions, and that an average supply of thirty gallons per day for each inhabitant is required, we shall require to supply ninety millions, or say one hundred millions of gallons of water daily. Then, if we take the depth of rainfall, by way of illustration, at thirty inches—though in reality it is one-sixth less near London, but probably more towards the source of the Thames,—and if we suppose 60 per cent of this quantity is made available for use, then an acre, or 43,560 square feet of land, with an annual available gathering of 18 inches of water, will give a daily supply of 1200 or say 1000 gallons, and hence to collect the quantity required the gathering area must be 100,000 acres, or 12½ miles square. An area therefore, equal to that on which London stands would suffice to collect water enough as rain to supply all the wants of the inhabitants. Should a supply of 200 millions of gallons per day be required, a gathering area of about 17½ square miles would become necessary. So far as quantity is concerned. therefore, it does not appear to be necessary to travel very far from London to obtain an adequate water supply.

The parent force of all the fresh water to be found on the earth is the ocean, and the atmosphere is the vehicle by which it is translated from place to place. Vapor rises from water at all ordinary temperatures, but the higher the temperature the larger the quantity of water distilled over in a given time. But when the temperature of the atmosphere falls, from any canse, the invisible vapor suspended in it condenses and forms fogs, dew and rain. So, in like manner, moisture may be absorbed by the atmosphere in one part of the earth, and precipitated in another, and in summer the increased capacity of the atmosphere for moisture causes it to be exhaled from trees and other vegetation, and the surface of the earth, during the heat of the day, is consequently dried up. When the winds blowing from the ocean strike upon the colder land, and especially when driven upwards upon the colder tops of mountains, the moisture of the air is wrung out as when a sponge is squeezed, and falls as rain, which rain refreshes the earth and recruits the rivers. The amount of rain which falls on a given area in the course of the year in every part of the civilized world is pretty accurately known by the establishment of rain gauges, by which the rainfall on a determinated area is accurately measured, and by comparing the average rainfall with the average volume discharged by the rivers of a given district, the proportion of a rainfall available for the supply of waterworks becomes known. But accurate daily measurements have been made of the discharge of small streams through periods of several years, which have determined the proportion between the rainfall and that which passes off through them. In a flat country with an impervious soil this proportion is much less than in a mountainous country or a porous soil; for in the one case it runs rapidly into the rivers without suffering much loss from evaporation, and in the other it sinks rapidly into the earth, reappearing in springs, and thus suffers little diminution in quantity from evaporation. A small quantity of the rainfall is consumed in promoting vegetation—certainly much less than one per cent—and there is also a loss or gain by alternations of temperature between day and night, by which water is taken up and let down alternately, and by which the air may finally pass away with much moisture in it. But the great loss arises when the water is spread over the face of a flat country in a thin sheet underlaid by an impervious soil.

Sixty per cent. is a common proportion of the rainfall to find its way into the rivers, but sometimes the proportion is only fifty per cent., and sometimes it reaches seventy-five.

The rain falling over large cities is necessarily contaminated by soot and the gases arising from combustion and effete matter to an extent sufficient to render it unfit for most purposes of domestic use, and in highly cultivated districts. where much manure is used, it may receive some organic impurity from this source. Most of its contaminations, however, are received below the surface, from earthy salts or oxydized metals, or chalk in the soil, or from previous accumulated decay below the surface, where the oxydation of the peccant matter has been prevented. Living matters, whether animal or vegetable, purify and improve water, but in autumn when vegetation decays, the water may suffer injurious contamination from this cause, and the proximity of forests is objectionable in consequence.

The gathering grounds should therefore be carefully located so as to be as free as possible from the various sources of contamination, and if properly shaped reservoirs are used a moderate area will suffice. [*English Paper.*

## Chrome Steel.

The following is a paper on "Chrome Steel," read by General Carrington, of the United States Army, at the recent meeting of the British Association.

The report of the committee on steel invitet a statement regarding the new alloy of iron with the oxide of chromium, which affords a steel, having strength, ductility, elasticity and uniformity, unknown to the best of English or German steel. While the labors of Huntsmann and Heath made the crucible cast-steel to surpass old forms of blister and shear steel, the use of chrome is a still greater advance towards a perfect metal. Chromium unites with the iron. It is a metal while carbon is not. It has little or no affinity for oxygen, and is not affected by excessive heating, while carbon, which has affinity for it, is liable to be burnt out of steel by excessive heat. Such is the opinion of Capt. Jas. B. Eads, engineer-in-chief of the St. Louis bridge over the Mississippi river, the largest steel bridge in the world. Its tensile strain is 198,-970 lbs. to the square inch while the highest strength given in "Percy's Metallurgy," page 870, is 123,900 lbs. per square inch. For forging it may be heated almost to a white heat without fear of injury; in fact, it is desirable that it be worked at a high heat, except in punching, which should be done at a mild heat. For tempering, the steel should be dipped at a low red heat as shown in the shade. All tools forged from a large body to a small edge should be allowed to cool off after forging, and be re-heated for tempering. The interior of the tool retains the heat at which it was forged after the exterior surface has cooled, and is too hot to put in the water for tempering, as it is liable to crack. For annealing, heat uniformly to a low red heat, and cover well in any of the usual annealing substances. For welding, heat, then lay the pieces together, and tap quickly and lightly until they adhere, then gradually increase the blows until the weld is complete. To harden well is to harden at the lowest heat at which it will take temper. A simple method of arriving at the proper heat for hardening is to place the end of a bar in the fire and heat it. Take it out, and note the different degrees of heat the whole length of the heated portion; then plunge into cold water. After cooling, break off a little at a time with a hammer across the anvil. If the point of the bar has been too hot, the grain will show at first coarse and granular, gradually becoming finer, until you reach the point where the bar was heated to a dull red, and then the grain will be found fine and fibrous, and the steel harder, stronger, and tougher than when the heat was greater. The point where the fine fibrous grain appears was at the proper heat when dipped, and that is the heat required for successfully hardening tools from chrome steel.

Exhaustive tests have been made of this steel in the United States, both at West Point foundry, and at the Washington navy-yard. Chief Engineer Fithian, U. S. N., in a report to Admiral Goldsborough, states, "that this metal performs three or four times more work than the best tools of carbon steel. It has uniform textures whether in large or small masses; it can be welded and worked with the same heat and ease that wrought iron can, and can be made into all the various forms required for machinery without danger of being destroyed by overheating." The chromium is found as an oxide, and may be combined with the ordinary iron, or with the Bessemer, and in all places and relations it gives a new and permanent value to the product. Toughness as well as hardness comes from graded heating, and it is submitted that the test of a large ingot by the manufacture of large ordnance may lessen the weight of guns while increasing their efficiency and safety. Unfortunately, the appropriation of but 40,000 dollars by the United States Congress allows no test upon a scale commensurate with the value of the product.